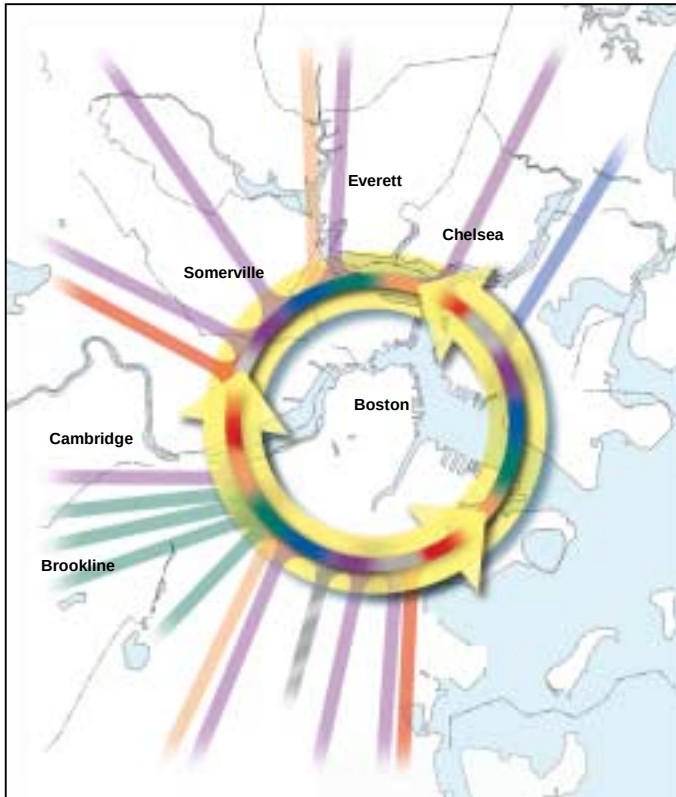


Attachment 5.3

**Urban Ring MIS Final Report
Executive Summary**



Major Investment Study of Circumferential Transportation Improvements in the Urban Ring Corridor

MIS FINAL REPORT

Executive Summary

July 2001



Massachusetts Bay
Transportation Authority



U.S. Department of Transportation
Federal Transit Administration



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EXECUTIVE SUMMARY

S.1 Introduction

The Urban Ring Major Investment Study (MIS) Final Report summarizes the development and evaluation of a wide range of transportation alternatives for serving the growing crosstown corridor outside downtown Boston, and outlines a strategy and schedule for phased implementation of the recommended alternatives. By reducing transit trip times, the alternatives identified in the MIS will achieve both major diversions of auto trips to the transit system and greatly increased mobility for transit users. The alternatives will provide direct transit access to locations and low income and minority populations currently underserved while supporting access to jobs and infill development. By connecting with every commuter rail line, radial transit line and most of the bus system, the Urban Ring will reduce congestion on local buses and the rail system in the Core of Boston.

The roughly circular Urban Ring Corridor (the Corridor) includes portions of Chelsea, Everett, Somerville, Cambridge, Brookline and Boston as shown in Figure S-1. Approximately 15 miles long and 1 mile wide, the Corridor is growing faster than the regional average and will contain over 314,000 residents and over 360,000 jobs by the year 2025. Every Massachusetts Bay Transportation Authority (MBTA) commuter rail, heavy and light rail transit line, the Silver Line and the Piers Transitway currently under construction, as well as over half of all MBTA bus routes, currently cross the Corridor, yet directness of transit travel along the Corridor today remains poor. Transit trips to and from the Corridor require twice as many transfers as the average for the metropolitan region, and transit trips travel at an average speed of less than 8 miles per hour compared to a regional average of over 15 miles per hour. This poor performance is largely due to the indirect routing that transit travelers must currently use for crosstown trips, compounded by inadequate connections with the radial transit and commuter rail system.

To address these needs, the MIS developed alternatives ranging from low-cost conventional buses to Bus Rapid Transit (BRT), rail systems and various combinations of each. Each alternative was evaluated to identify benefits, costs and potential environmental issues. A community-based planning process was used throughout the study, including extensive participation from citizen, business and environmental groups, and municipalities, as well as representatives from many of the areas largest educational and medical institutions. The extensive public involvement program included workshops, outreach briefings and general public meetings with a Working Committee and its Subcommittees, providing input and guidance throughout the process.

Through this public process, the range of alternatives was steadily reduced from 15 down to three. All three alternatives consist of Transportation System Management (TSM) measures, Bus Rapid Transit (BRT) service, and Supporting Elements such as new commuter rail stops at Urban Ring interfaces. They differ in the type of rail service included. Alternatives A1 and B include Light Rail while Alternative A2 utilizes Heavy Rail. A multi-phase implementation concept and schedule was developed where each phase builds upon the previous phase until all the elements of the alternatives are in place.

Phase 1: New and improved crosstown and express buses (2001-2005)

Phase 2: Bus Rapid Transit system with new or improved commuter rail connections (2006-2010)

Phase 3: Light or Heavy Rail between Assembly Square and Dudley Square (2011-2015)

By Phase 3, each alternative would connect with all existing and planned transit and commuter rail lines, carry nearly 300,000 riders daily, save travelers approximately 50,000 hours daily, increase systemwide transit ridership by 47,000 daily, and relieve bus and core subway congestion effectively increasing system capacity. Moreover, each alternative is consistent with and supported by local and regional land use and economic development policies, and is capable of being phased incrementally over time. The Phase 3 alternatives feature a rail system approximately 6 to 7 miles in length in the most heavily traveled portion of the Corridor integrated, with high-frequency Bus Rapid Transit (BRT) routes on both ends. Local bus routes act as feeders to both the LRT and BRT routes.

This MIS Final Report Executive Summary describes the following:

- Project Background
- Planning Process
- Purpose and Need
- Goals, Objectives and Evaluation Measures
- Alternatives Considered
- Project Benefits and Potential Impacts

The MIS Final Report Executive Summary also describes next steps to take place concurrent with and following completion of the Major Investment Study of transportation improvements in the Urban Ring Corridor and filing and Expanded Environmental Notification Form (ENF) for the project:

- Submit an Expanded ENF for MEPA review and establish the special review procedures;
- Conduct a coordinated State (MEPA) and Federal (FTA/NEPA) review;
- Prioritize and implement Phase 1 bus routes through the MBTA service planning process;
- Secure funding for rolling stock and operating costs for the Phase 1 bus routes;
- Define the scope, schedule and budget to complete the DEIR/DEIS for the Phase 2 system;
- Secure funding for design and construction of facilities, procurement of rolling stock, and operating costs of the Phase 2 system;
- Continue the public outreach and project reporting process.

A unique feature of the Urban Ring planning process has been the extraordinary level of cooperation and coordination between the MBTA and the six municipalities that comprise the Urban Ring Corridor. In a virtually unprecedented action, these six jurisdictions formed a Regional Planning Compact for the sole purpose of jointly planning and supporting the Urban Ring transit project. The result has been a high degree of participation and collaboration between regional and local transportation, land use and economic development agencies.

The planning and project development process for the Urban Ring has followed the Federal Transit Administration guidelines for Major Investment Studies in effect at the start of the study and has been updated to reflect changes in those guidelines that have occurred during the Study.

S.2 Project Background

The idea of transportation improvements in the Urban Ring Corridor has been the subject of considerable public debate and analysis dating back to the early 1900's when a system of circumferential highways was proposed and later abandoned. From the 1940's through 1960's, a system of concentric circumferential highways was again proposed around Greater Boston. Route 128 was Greater Boston's first circumferential highway, followed by construction of Route 495 and the outer ring. Finally, the "Inner Belt" Highway was proposed to encircle Boston 2 to 3 miles from Downtown. This project progressed only through design and a partial land acquisition/clearance stage. The project was cancelled and never built, largely due to strong public opposition.

The 1970's marked a period of fundamental change in state policy away from highways in favor of transit-based solutions to mobility problems. The 1972 Boston Transportation Planning Review (BTPR) was the first major study that articulated the characteristics of an expanded Boston core area linked by a circumferential transit, rather than highway, Corridor. The Corridor was envisioned to generally follow the alignment of what was to have been the Inner Belt Highway. The BTPR report concluded that:

"The Transit Circumferential would intercept all the radial transit lines it crosses, permitting direct transfer between facilities. The primary function of the circumferential would be as a distributor from these radials to the intense demand areas of the fringe. Secondly, it would serve line haul circumferential Corridor movements, and only incidentally a collector function in certain residential

areas. The benefits the Transit Circumferential offers are as a functioning part of the overall transit network more than as a facility by itself - in the decongestion of the core and the distribution improvement for the radial lines."¹

In 1976, the Program for Mass Transit (PMT) again identified the former Inner Belt Highway Corridor as the preferred location for the development of circumferential transit service. Both the 1977 and 1978 updates of the PMT continued to recommend transit system development in the Inner Belt Corridor.

Starting with the Circumferential Transit Feasibility Study in 1989, potential ridership in the Urban Ring Corridor began to be quantified and the cost and feasibility of various alternatives were examined in greater detail. The results of the evaluation indicated that a number of options might provide cost-effective solutions to meet long-range Corridor travel needs. Without a major investment in the Corridor, traffic and transit operations would deteriorate significantly and growth in activity centers would be restrained. Costly capacity improvements on the Red and Green lines would be needed in the absence of circumferential Corridor improvements.

However, recognizing the need for alternatives to the high-capital costs associated with the long-range options, in 1993 the MBTA also examined what could be implemented more readily and at lower cost. As a result, in 1994 the MBTA initiated three new limited-stop crosstown bus routes referred to as CT1, CT2 and CT3. While growing in popularity, these routes operate in mixed traffic and face the same roadway congestion delays as single occupancy vehicles. Again, in 1994 the PMT listed Inner Circumferential Transit as a long-term Tier 1 project. This category generally contains the projects that "have the potential to provide the greatest increases in transit ridership."

Recognizing the continued need for a long-term solution, in June 1993 the Boston Society of Architects Infrastructure Forum in collaboration with Northeastern University made The New Urban Ring the subject of Northeastern's Urban Design Charrette Series. The product of this effort, attended by community and institutional representatives, was an information base and advocacy-building framework to serve as part of a development program for different parts of the Urban Ring. This well-attended grass roots event highlighted the deep community-based support for transportation improvements in the Urban Ring Corridor and began to articulate the positive impacts that improved transit access and mobility would have on economic development and quality of life throughout the Corridor and the region.²

Local government support for the Urban Ring reached a major milestone in October 1995 when the chief executive officers of Boston, Brookline, Cambridge, Chelsea, Everett and Somerville signed the Circumferential Ring Regional Planning Compact (Urban Ring Compact). The Urban Ring Compact commits the six cities and towns to a direct participatory role in the MIS. Working through the MBTA, the Compact document states that its six member jurisdictions will work cooperatively so that local land use and economic development planning is coordinated with public transportation planning. Concurrent with development of the MIS, the Urban Ring jurisdictions have prepared a companion document describing the unified land use and economic development vision of the Corridor and how transportation improvements would support that vision. Fundamental to the Compact's vision is improved transit access for Corridor neighborhoods as well as employment centers, thereby raising the importance of the neighborhood function beyond the incidental role described in the 1972 BTPR. The Urban Ring Corridor and the six Compact jurisdictions are depicted on Figure S-1.

S.3 Planning Process

The planning and project development process for the Urban Ring has followed the Federal Transit Administration (FTA) guidelines for Major Investment Studies in effect in 1997. Since then, TEA 21 legislation has caused FTA to initiate changes to integrate the planning principles of the MIS into the

¹Boston Transportation Planning Review, Summary Report, October 1972, Page 3

² The Urban Ring was subsequently explored as a topic at the Harvard Graduate School of Design; MIT Transportation Program; Northeastern University School of Architecture; and the Boston Architectural Center.

environmental process. The basic steps in the Urban Ring planning process are listed below and described in the following sections:

- Define purpose and need
- Develop goals, objectives and evaluation measures
- Develop alternatives
- Describe potential impacts
- Evaluate alternatives

The MIS Final Report summarizes work performed and decisions reached at each of the above listed steps in the planning process. Throughout the MIS planning process, the six Urban Ring Compact representatives and other members of the Working Committee have played a major role, reviewing and commenting on technical work and helping to shape the alternatives that have emerged.

S.3.1 Public and Agency Participation

The MBTA's Urban Ring MIS Public and Agency Participation Program rests on a foundation of regional support and municipal cooperation. The depth of this support dates back 30 years to the rejection of the I-95 Inner Belt Highway and the continued growth in support for improved circumferential transit. The MBTA initiated the MIS largely in response to the strong interest in improved circumferential transit expressed by numerous parties. Foremost among them are the Regional Planning Compact representing the six cities and towns in the Corridor; the Boston Society of Architects Infrastructure Forum; the Circumferential Transit Employers Committee (CTEC) and the Medical and Scientific Community Organization (MASCO) representing companies and institutions; Move Massachusetts; and the Conservation Law Foundation. Many other business and citizens' groups have also supported the Urban Ring during the MIS process. The support of these groups has been invaluable to the public involvement effort.

At the outset, the Public and Agency Participation Program established and defined the responsibilities and relationships among the MIS participants. In addition to the MBTA and the Consultant Team, the principal participants included:

- The Working Committee;
- The Steering Committee;
- Subcommittees of the Working Committee;
- Local government agencies, including those of the six Urban Ring Compact Communities (Boston, Brookline, Cambridge, Chelsea, Everett and Somerville);
- Community organizations and institutions, including numerous neighborhood groups, employer associations, academic and medical institutions, civic associations, as well as individual residents.

The multi-jurisdictional nature of the Urban Ring (six municipalities, as well as regional planning agencies are involved) required extensive outreach and information sharing efforts on the part of the MBTA and the Urban Ring project team to insure adequate agency participation. To achieve this goal, the major federal and state agencies as well as local municipalities have been included in the Working Committee structure and meetings throughout the MIS study process. In addition, several meetings have been scheduled to coordinate certain aspects of the project as they arise.

The MBTA has held or participated in nearly 100 public meetings, workshops, and community meetings as part of the Urban Ring MIS. For the Urban Ring MIS, the MBTA has held or participated in five types of meetings:

- Meetings of the Working Committee, Steering Committee, and subcommittees;
- Workshops;
- General public meetings;
- Presentations to community and business groups;
- Other outreach.

As part of the outreach effort for meetings, the Public Participation Subcommittee developed an Urban Ring mailing list database of approximately 2,200 people, including residents of the project corridor and the region, government agency representatives, elected officials, representatives of major institutions in the project corridor, and others. The people on this list received notices of project activities, public meeting announcements, and copies of the Urban Ring brochure. The MBTA, Consultant Team, and Public Participation Subcommittee updated this database throughout the MIS process.

S.4 Purpose and Need

The Corridor has been the subject of many past transportation studies that have focused on several critical transportation needs. These studies, which span nearly 40 years, have identified solutions ranging from an “Inner Belt” Highway to a new circumferential rail transit line and new bus routes augmented by low-cost traffic engineering improvements. To date, improvements have been limited and no comprehensive program to address these mobility problems has been implemented. The purpose of the Urban Ring MIS was to review and update the needs assessment using the latest data and, working closely with the Compact communities, identify an implementable long-range plan for addressing the following:

- *Accessibility of the Corridor Transit System and Mobility of its Users is Inadequate:* The Corridor includes a large percentage of minority and transit dependent low-income households with lack of access to an automobile. There is a need to provide convenient high quality transit connections between emerging and established activity centers and neighborhoods located along the Urban Ring Corridor, as well as between the Corridor and the balance of the Region, while reducing transit travel times.
- *Transit Congestion in the Boston Core Remains a Problem:* Other planned capacity improvements don’t address a major cause of this congestion - the large and growing number of transit riders that must pass through the Boston Core in order to reach destinations along the Urban Ring Corridor.
- *The Environment is Negatively Impacted by High VMT and Congestion:* Established activity centers in the Corridor are impacting neighborhoods with traffic while emerging areas, including brownfield sites, lack good access to attract investment.
- *Economic Development is Constrained by Traffic Congestion and Poor Access:* It limits the development capacity of established areas and holds back emergent areas from reaching their full potential.
- *Needs are Immediate and Growing Rapidly:* A cost-effective phased approach is needed to start improvements immediately while building systematically toward the proposed long-range alternative.

S.4.1 Transit Accessibility and Mobility is Inadequate

The lack of circumferential connections in the Corridor has significant implications for accessibility within both the Corridor and the larger region. Access to activity centers (locations that generate a significant number of trips) and neighborhoods is often circuitous and slow. Roadway access requires travel on the limited number of congested crosstown arterials, or into and then out of Downtown Boston using the highly congested radial roadway network. Travel via the transit system is equally constrained. The options on the transit network include use of the crosstown bus network, which suffers from the limitations

of the roadway network, or circuitous routing via the congested radial rapid rail and LRT network and a transfer between lines in the central subway in Downtown Boston. Existing rail transit stations are concentrated along radial corridors that leave large geographic areas beyond convenient walking distance. This distance increases as you move away from the downtown core of Boston as the radial lines fan out leaving the areas between the “spokes” of the rail transit system dependent on increasingly congested bus service. This results in long trip times between areas that are relatively close together and places a disproportionate burden on the large percentage of transit dependent residents in the Corridor. It also produces, for households with access to one, a higher propensity to use the auto than might occur given the high levels of transit service and high levels of parking cost and congestion in the central portions of the Corridor. Year 2000 census data shows minorities comprise 45 percent of the total Corridor population compared to 21 percent of total regional population. Moreover, average household income in the Corridor is only 62 percent of average household income in the region (1990 Census is most current data for household income).

For origins external to the Corridor within the existing transit system, an average of 1.4 transfers per transit trip is needed to reach points within the Corridor, at an effective average speed of approximately 15 miles per hour. In contrast, for origins within the Urban Ring Corridor, an average of 1.2 transfers per transit trip is needed, but the average speed is less than 8 miles per hour. This slow speed is in part reflective of the MBTA’s need to serve the predominant flow of traffic into the Boston Core. The result is the need for transit trips within the Corridor to travel relatively greater distances via the core and then out to reach these outlying destinations along the Corridor. As a point of comparison, the average number of transfers for the overall Boston metropolitan region is only 0.71 transfers per transit trip. Thus, the average number of transfers required for transit trips to and from the Urban Ring Corridor is currently twice the average for the metropolitan region. The existing public transportation network within and around the Corridor is depicted in Figure S-2.

Without the Urban Ring, the transit system of the future will not accommodate these important regional access requirements. As demonstrated in Figure S-3, the 2025 “No Build” transit and commuter rail system provides additional radial services, but does not address crosstown accessibility and mobility problems described above.

S.4.2 Inner Core Rapid Transit Congestion Remains a Problem

The high reliance on the radial transit network and the large number of Urban Ring trips that pass through the Boston Inner Core adds to the growing levels of congestion on the central portions of the MBTA rail network. Capacity problems currently exist on the Blue Line and the Green Line. Improvements in the central subway system as part of the Long Range Regional Transportation Plan will provide some additional capacity. However, these improvements only marginally increase Core capacity and do not address a major cause for the congestion – namely a system configuration that forces many transit users to pass through the Inner Core to reach destinations along the Urban Ring Corridor. The rapidly increasing demand placed on the system by this pass-through transit traffic is expected to consume the planned new capacity in the central subway system, particularly on the Green Line.

The contribution of Urban Ring trips to these subway congestion problems varies by line. As many as 40 percent of all rail line unlinked trips involve either a boarding (entrance of rail vehicle) or alighting (exit of rail vehicle) in the Corridor. This percentage is highest for the Green, Orange and Blue Lines. While smaller, the percentage for the Red Line is significant at an estimated 30 percent. While many of the trips to and from Urban Ring locations also involve an origin or destination in Downtown Boston, a large percentage do not, and travel to the Boston Core only to transfer to another line or ride through to a destination outside the Boston Core. Diverting Urban Ring trips to new crosstown transit facilities outside Downtown Boston would greatly reduce the demand on the core rapid transit system and the need for additional capacity expansions beyond those already planned.

S.4.3 The Environment is Negatively Impacted

Without the infrastructure to support transit-oriented development in the Corridor, auto-oriented development will continue with its associated environmental impacts. These impacts include a lessening of air quality, increase in ambient noise, and the inefficient use of scarce land for parking, roadways, and other auto-related uses.

S.4.4 Economic Development is Constrained

Roadway traffic congestion and poor transit access pose significant impediments to economic development in many areas of the Corridor. It limits the development capacity and quality of life in established areas and can hold back emerging areas from reaching their full potential. Within the central portions of the Corridor between the Crosstown/Ruggles area in Boston and the Lechmere/North Point area of Cambridge, the combination of high levels of traffic congestion and limited regional transit access places limits on further development of many activity centers. This portion of the Corridor, most notably in East Cambridge and around the Longwood Medical Area of Boston, contains well-established employment centers, yet is constrained by lack of crosstown transit. Other areas include the southeast portions of the Corridor in Boston and the northern portions of the Corridor in the municipalities of Somerville, Everett and Chelsea. The economies of these municipalities are re-emerging and actively seek better transit to support development of their sites, including brownfields. Most of these areas are currently limited to auto-oriented uses due to lack of transit service, which would be a prerequisite for higher density mixed-use development. Local and regional land use policies would generally favor much higher development densities with improved transit access and reduced dependence on auto travel.

S.4.5 Needs are Immediate and Growing Rapidly

The already congested Corridor is projected to grow at three times the rate of the region as a whole, yet no increase in crosstown transit capacity is currently programmed. Between 1990 and 2025 the population of the Corridor is projected to grow 34 percent compared to 11 percent for the region as a whole, and employment in the Corridor is projected to grow 81 percent compared to 26 percent for the region as a whole. Along with this growth will be a commensurate increase in trip making. Cost-effective improvements to crosstown transit access are needed in the near and mid-term while the more substantial capital, environmental, design, and construction challenges of the long-range project are addressed. The corridor contains existing and abandoned railroad rights-of-way, transit easements dating from the failed Inner Belt Highway, and existing transit facilities with expansion potential, all of which present opportunities for incrementally building a cost-effective network of transit services in the Corridor.

S.5 Goals, Objectives and Evaluation Measures

The identified problems and needs listed above were grouped into five basic categories for purposes of organizing the establishment of formal project goals. Within these five categories a total of ten specific goals have guided the process of Urban Ring alternative development and evaluation. The Urban Ring goals, objectives and evaluation measures were developed and adopted through an extensive public involvement process. A Working Committee, eight Subcommittees and several half- and full-day workshops provided the forums for developing consensus on the following goals, as well as all the alternatives and their refinements.

- Transportation
 - Improve access for all Urban Ring Corridor origins and destinations for all users
 - Improve crosstown access for non-single occupant vehicle (SOV) users
 - Reduce congestion on the existing radial transit network
 - Reduce the growth in overall single occupant vehicle (SOV) travel

- Environment
 - Contribute to the attainment of national, state, regional and local community environmental goals
- Economic Development and Land Use
 - Reduce transportation-related impediments to economic development
 - Support local, regional, state and federal development goals
- Cost Effectiveness
 - Improve the efficiency and effectiveness of buses and other rubber tire transit services
 - Support the phased implementation of an integrated transportation and land use vision for the Urban Ring Corridor
- Implementation and Phasing
 - Develop a cost effective, implementable preferred investment strategy for mobility improvements

Evaluation measures were established for each of the goals. Most of the evaluation measures are quantitative, such as comparing the travel-time savings (in hours) of each alternative as a measure of improved access. Other measures are more qualitative, such as the extent to which each alternative supports development goals. Paragraph S.7 addresses how each phase and alternative addresses these goals, and Tables S-10, S-11, and S-12 provide summary level results for each phase and alternative measured against these goals.

S.6 Alternatives Considered

Based on the findings of the baseline analysis and the adopted project goals and objectives, the Urban Ring alternatives were limited to modes other than single-occupant automobiles. Previous studies had identified and ultimately rejected highway solutions to Corridor access and mobility problems. Therefore, emphasis was placed on developing alternatives focused on public transportation improvements. Recognition was also given to the role of ride sharing in Caravan for Commuters, as well as the numerous private transportation services and other activities undertaken by the many Transportation Management Associations (TMA's) present in the Corridor.

The development, refinement and evaluation of the Urban Ring alternatives, consistent with the overall planning process described above, included the following steps:

- Define Linkages
- Preliminary Alternatives
- Screening Process
- Alternatives Development
- Final Alternatives

S.6.1 Define Linkages

Initially, the Corridor was divided into 20 subareas, aggregations of traffic analysis zones at the subzone level using the CTPS 986 zone system. The mobility needs and desired linkages for each subarea were analyzed, which produced a large number of possible new linkages that were grouped into three categories: local area improvements, connections to other Urban Ring subareas and regional connections.

The need for improved local access to the existing transit network along with access to nearby activities and adjacent subareas was identified. At the local level, the need for higher-frequency transit service not subject to local street congestion was identified. For trips to adjacent subareas, a number of significant patterns emerged. In the northern portion of the Corridor, the need to link Everett and Chelsea to East Boston and Logan Airport on the east and the Wellington Orange Line station on the west were identified. In the central portion of the Corridor, the need to link Somerville, Charlestown and East Cambridge, and to link Cambridge and Somerville to areas south of the Charles River such as the Longwood Medical Area were highlighted. In the southern portion of the Corridor, improving transit connections northward is important to serving both existing land uses, such as the BU Medical Center, and to support development of emerging areas such as Crosstown/Ruggles, Dudley Square, Uphams Corner, Columbia Point and New Market. Equally important, regional access from all Ring subareas to the suburbs was identified as a compelling priority. The Ring would facilitate suburban commutes to Urban Ring destinations and reverse commuting of Corridor residents to employment opportunities in the suburbs.

S.6.2 Preliminary Alternatives

The next step was to take the desired linkages and formulate Corridor-wide preliminary alternatives. These Corridor-wide options were developed based on four modal/level-of-investment options, two approaches to development of alternatives and the identification of supportive elements, such as commuter rail connections.

Modal/Level-of-Investment Options

The full range of available transit technologies was reviewed based on the ability to meet project goals and objectives, technical feasibility, scale and compatibility with existing and planned transit systems. As a result, the conventional bus system improvements (TSM), Bus Rapid Transit (BRT), Light Rail Transit (LRT) and Heavy Rail Transit (HRT) technologies were identified for further consideration.³

Generally, the level of capital investment required increases through the range of technology, with TSM being the least capital intensive and HRT being the most capital intensive due to its requirement of 100 percent grade separation and high-level platforms. Within the LRT technology group, two levels of investment were identified. LRT Level 1 maximizes the use of lower-cost, at-grade transit reservation wherever physically possible and limits the use of expensive tunnels and underground stations. LRT Level 2 builds on the LRT Level 1 approach and adds additional sections of tunnel to improve the speed, capacity and efficiency of the LRT operation. The capital requirements of the LRT Level 2 approach are comparable to the capital requirements of HRT approach.

Two Approaches

For each of the modal/level-of-investment options, two approaches to alternative development were used. The first was to apply the given technology from one end of the Corridor to the other, and the second was to apply different technologies in different areas of the Corridor. These two groups were identified as End-to-End Alternatives and Combination Alternatives, respectively.

Supporting Elements

In addition to the Corridor-wide alternatives, several important supporting elements were identified. These improvements fall into the following three categories: new commuter rail stations, existing transit station access improvements to facilitate Urban Ring interface and facilities to support new express bus routes. The supporting elements can be added to any End-to-End or Combination Alternative.

The process described above resulted in the identification of 15 preliminary Corridor-wide alternatives and three packages of supporting elements that can be combined within any of the Corridor-wide options.

³ Transportation System Management (TSM) is low cost and relies on conventional bus technology operating over new routes and modified versions of existing routes with selected street and intersection improvements. Bus Rapid Transit (BRT) is a high technology bus compatible with Silver Line service, operating on its own right of way in large segments of the Corridor. Light Rail Transit (LRT) would be Green Line compatible rail service drawing power from overhead catenary wires. Heavy Rail Transit (HRT) would be 100% grade separated, high-platform rail service drawing power from a third rail similar to the existing Orange Line.

S.6.3 Screening Process

A screening process to identify fatal flaws and other serious problems was applied to the 15 preliminary Corridor-wide alternatives at one of the early Urban Ring Workshops. The purpose of this effort was to reduce the long list of alternatives to a more manageable number for more detailed descriptions and evaluation. The key screening criteria included:

- Environmental constraints
- Markets served and projected ridership
- Estimated costs
- Compatibility with the existing MBTA system
- Physical constraints
- Phasing potential
- Redundancy

The screening process eliminated nearly half of the preliminary alternatives, primarily for reasons of system incompatibility, poor phasing characteristics, redundancy with other alternatives or cost. Alternatives that emerged from the screening process were further refined with sufficient detail so that they could be carried forward into the alternatives evaluation and refinement.

S.6.4 Alternatives Development

The viable preliminary alternatives, including TSM, were developed in greater detail and evaluated through a process of reporting and feedback with the Urban Ring technical committees. The range of alternatives consisted of:

- “No Build” Alternative
- TSM Alternative
- End-to-End and Combination Alternatives

“No Build” Alternative

This alternative represents the transportation system in Greater Boston that is expected to be in place in the year 2025 in the absence of any Urban Ring improvements. Sometimes referred to as the “Do-Nothing” Alternative, it is comprised of the existing MBTA system shown in Figure S-2, with the addition of all the projects contained in the 2025 Regional Transportation Plan. Figure S-3 depicts the transit and rail projects in the 2025 Regional Transportation Plan. The “No Build” alternative provides a reference point against which the benefits and costs of the Urban Ring TSM and various End-to-End and Combination Alternatives are compared. The projected transportation networks were also defined for the years 2003 and 2010. Urban Ring alternatives would be added to the projected 2003, 2010, and 2025 networks.

TSM Alternatives

The TSM Alternatives represent relatively low levels of investment and, like the “No Build,” are required as a point of comparison against which the benefits and costs of the more capital-intensive “Build” Alternatives must be compared at each phase of the project. The TSM Alternative developed for Phase 1 of the Urban Ring is comprised of the following new and improved conventional bus routes:

- New Express Commuter (EC) bus routes
- New crosstown (CT) bus routes
- Modifications to existing CT bus routes
- Basic bus service improvements

The non-redundant routes would continue to operate in support of the Phase 2 and Phase 3 alternatives. There are two additional TSM alternatives for the years 2010 and 2025 consisting of the Phase 1 TSM alternative with the transportation networks in place at those points in time.

End-to-End and Combination Alternatives

The end-to-end alternatives consisted of a single transit technology, while different technologies in segments of the Corridor were considered for the combination alternatives. The alternatives development, screening, and evaluation process is summarized in the diagram contained in Figure S-4. The alternatives were developed through an iterative process from those surviving the preliminary alternatives analysis. The surviving end-to-end alternatives consisted of a single technology, either BRT or LRT, from East Boston on the north end of the Corridor to JFK/UMass on the south end of the Corridor. The surviving combination alternatives consisted of rail in the most densely traveled portion of the Corridor between the Orange Line at Assembly Square and the Orange Line at Ruggles, with overlapping BRT routes serving the northern, southern and eastern portions of the Corridor.

All of these alternatives would require significant capital investment. Some additional consolidation and definition occurred early in their development following the fatal flaw screening process based on input from other Workshops and technical subcommittees. Each of the alternatives was then defined to an equivalent level of detail, including development of a conceptual operating plan and a set of 1"=200' scale plan and profile drawings to enable analysis and comparison of such measures as ridership, costs and environmental consequences. The various end-to-end and combination alternatives considered are summarized in Figure S-4.

Each of these alternatives included a tunnel under the Charles River, either near the BU Bridge/Park Drive or Kenmore Square. The Light Rail alternatives feature an alignment and operating plan that interlines with the Green Line Extension at New Lechmere. The Heavy Rail alternative features an alignment and operating plan that interlines with the Orange Line at Sullivan Square.

The analysis of the various end-to-end and combination alternatives resulted in several significant findings that would lead to further narrowing of the alignments and technology. The analysis showed that the end-to-end BRT Alternative would not adequately reduce radial transit congestion and would have the most limited capacity relative to cost. The analysis also showed that all the end-to-end rail alternatives exhibited much lower cost effectiveness than the combination alternatives consisting of rail in the most heavily traveled portion of the Corridor between Assembly Square and Dudley Square, with overlapping BRT routes serving the northern and southeastern portions of the Corridor.

One of the combination alternatives which followed the available Grand Junction railroad right-of-way between Main Street and Gore Street in East Cambridge, was strongly opposed by the City of Cambridge because it would not directly serve the growing corridor between Kendall Square and New Lechmere. Because of strong benefits in other areas, options for modifying this mostly at-grade LRT alternative to directly serve Kendall Square and New Lechmere were explored in conjunction with the City of Cambridge. The remaining combination alternatives were presented and discussed with stakeholders and modified to incorporate and further examine certain features from the earlier alternatives.

S.6.5 Final Alternatives

The final alternatives resulting from the public evaluation process consist of a revised TSM Alternative and two versions of Light Rail Transit (LRT) and one version of Heavy Rail Transit (Heavy Rail) in combination with Bus Rapid Transit (BRT), supporting elements, and the non-redundant Crosstown and Express Commuter bus routes. All BRT routes in the final alternatives are consistent and compatible with the MBTA's current plans for the Silver Line. The 2025 "No Build" Alternative identified previously was unchanged and remained the point of comparison. The following paragraphs and referenced figures and tables at the back of this report provide a detailed description of the final Phase 1, 2, and 3 alternatives considered for implementation in the Corridor.

Each of these alternatives would be developed in three phases:

- Phase 1 (2001 - 2005): TSM

- Phase 2 (2006 - 2010): TSM + BRT and Supporting Elements
- Phase 3 (2010 - 2015): TSM + BRT and Supporting Elements + Rail Transit

The sole difference between the alternatives occurs in Phase 3 and regards the rail alignment, profile, and technology. Phase 1 and Phase 2 can be implemented independent of that decision, and Phase 1 is separable from, and could proceed independently from, both Phases 2 and 3. Phase 3 provides a choice between an all-tunnel Urban Ring rail system crossing the Charles River in a tunnel at Kenmore Square that could accommodate either Light Rail (Alternative A1) or Heavy Rail (Alternative A2) technology, or a partially at-grade Light Rail system north of the Charles River with a tunnel crossing near BU/Park Drive (Alternative B).

In Phase 1, TSM elements, (aka improved bus service) not requiring major new construction would be implemented.

In Phase 2, Bus Rapid Transit (BRT) routes and supporting elements such as commuter rail stations at Urban Ring interfaces would be constructed and implemented. A fleet of low emission BRT vehicles would be purchased, and an additional BRT vehicle maintenance facility capacity provided. The TSM bus routes from Phase 1 would continue where not redundant to the BRT service. The BRT routes would operate at frequencies comparable to existing transit lines with station stops as shown on the diagram. During Phase 2, the environmental filings are made for the subsequent Urban Ring rail system of Phase 3.

In Phase 3, an Urban Ring rail service between Assembly Square in Somerville and Dudley Square in the Roxbury neighborhood of Boston would be constructed and implemented. A fleet of electric powered rail transit vehicles would be purchased, and an additional rail transit vehicle maintenance facility capacity provided. The TSM, BRT and supporting elements of Phase 1 and 2 would continue where not redundant to the Phase 3 Urban Ring rail service. The route and technology alternatives for implementation of the Phase 3 Urban Ring rail service are summarized below.

<u>Alternative</u>	<u>Description</u>
A1 and A2	Cross the Charles River at Kenmore Square, follow the shortest route, and require the fewest stations to connect with the MBTA's radial lines. The gentler curves of the all-tunnel alignment allow the choice of either Light Rail (Alternative A1) or Heavy Rail (Alternative A2) transit technology.
B	Crosses the Charles River near the B.U. Bridge and Park Drive and follows a longer route requiring more stations to connect with the MBTA's radial lines. In order to offset the costs of the longer route and additional stations, use of surface alignments is maximized in Somerville and Cambridge. Use of Light Rail is required in order to handle tight turns and operate within and across street traffic.

S.6.5.1 Phase 1 (2001-2005)

Phase 1 proposes a significant expansion in the number and reach of the Crosstown (CT) bus routes to provide one-seat rides within the Corridor, and the addition of new Express Commuter (EC) service to provide single seat radial and crosstown service from suburban locations into the Corridor⁴. Figure S-5 depicts the proposed Phase 1 bus routes. The proposed Phase 1 bus routes will utilize 40-foot, low-floor, low-emission buses. It is anticipated that capacity expansion of existing MBTA storage and light maintenance/fueling facilities will be necessary to accommodate the additional buses added to the MBTA fleet to provide the full proposed Phase 1 services.

⁴ In Phase 1 the proposed CT3, CT4 and CT5 routes would serve locations currently served by non-MBTA shuttle bus operators. Implementation of Phase 1 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors.

All the proposed EC routes will operate similar to existing MBTA Express Bus service (including “reverse direction” service). There are a total of 11 proposed CT routes consisting of modifications to three existing CT routes and the addition of eight new CT routes. The proposed CT routes will operate similar to existing MBTA CT limited-stop service connecting rapid transit nodes and major activity centers. Tables S-1, S-4, and S-5 summarize the operating characteristics of the Phase 1 bus routes.

In Phase 2 and Phase 3 the alternative of simply continuing all the Phase 1 TSM routes without BRT, Supporting Elements, or rail was also examined.

S.6.5.2 Phase 2 (2006-2010)

Phase 2 builds upon the proposed Phase 1 bus routes by proposing to add Bus Rapid Transit (BRT) routes that utilize 60' articulated low-floor, low-emission vehicles, segments of exclusive busway, ITS features, and supporting elements to improve connections with radial transit and commuter rail lines. Some of the BRT routes in Phase 2 would be new, and others are modified or converted versions of the Phase 1 bus routes⁵. A total of seven BRT routes are proposed in Phase 2 as depicted in Figure S-6. The operating characteristics of the Phase 2 BRT routes are summarized in Tables S-2, S-4, and S-5. Details of the BRT routing and station locations will be determined during the Phase 2 environmental process.

◦ Changes to Phase 1 Routes Occurring in Phase 2

Five of the Phase 1 bus routes (CT2, CT3, CT4, CT5, CT8) would be converted to Bus Rapid Transit service in Phase 2. One of the EC routes (EC1) is dropped because it becomes redundant to a new Commuter Rail/BRT connection at Sullivan Square, and the CT11 route is modified to follow the former CT4 route north of Dudley/Hampden corner to provide better coverage in tandem with the new BRT routes.

◦ Supporting Elements: New or Expanded Commuter Rail Stations

Downtown Chelsea:	Expand and improve existing station on the Newburyport/Rockport Line
Sullivan Square:	New station stop near junction of the Newburyport/Rockport and Haverhill Lines
Gilman Square:	New station stop on the Lowell Line
Union Square:	New station stop on the Fitchburg Line
Yawkey:	Expand and improve existing station on the Framingham/Worcester Line
Ruggles:	Expanded stop with platforms on both sides of Northeast Corridor
Uphams Corner:	Improved stop on the Fairmont Line

S.6.5.3 Phase 3 (2011-2015)

Phase 3 of the Urban Ring is proposed to add a new Urban Ring rail system between the Orange Line at Assembly Square and the former Orange Line terminus at Dudley Square. Phase 3 has two possible alignments known as Alternative A and Alternative B. Alternative A has the option of being either Green Line compatible Light Rail Transit technology (A1) or Orange Line compatible Heavy Rail Transit technology (A2). Alternative B must be Light Rail Transit technology due to the presence of grade crossings and sharper curves. Through the MIT campus the tunnel alignment for Alternatives A1 and A2 could be beneath either the Grand Junction Railroad, which was the basis of the ridership forecasting, or Vassar Street. The choice of alignment and technology for the Urban Ring rail transit system will be determined during the Phase 3 environmental process.

◦ Alternative A1 – LRT Via Kenmore

The following description pertains to Alternative A1. It crosses the Charles River at Kenmore Square and, compared to Alternative B, follows a shorter route with fewer stations needed to connect with the MBTA radial lines. Alternative A1 uses low-floor Light Rail Transit (LRT) technology compatible with the MBTA

⁵ In Phase 2 the proposed BRT1, BRT2 and BRT6 routes would serve locations currently served by non-MBTA shuttle bus operators. Implementation of Phase 2 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors to the extent that they have not already been resolved in Phase 1.

Green Line, and interlines with the Green Line Extension west of New Lechmere. The alignment and stations of Alternative A1 are all in tunnel except at Assembly Square and Sullivan Square. Alternative A1 in Phase 3 of the Urban Ring includes the non-redundant conventional bus, BRT, and supporting elements of Phase 2.

Changes to Phase 2 Routes Occurring in Phase 3

BRT5 Dropped – The LRT routes provide this service

BRT2 Modified – This route is changed from Revere Beach Parkway to the busway adjacent to commuter rail.

Alternative A1 is depicted in Figure S-7. There are two overlapping rail routes in Alternative A1 as summarized below and in Tables S-3, S-4, and S-5.

Between Medford Hillside and New Lechmere the LRT#2 route assumes the Green Line Extension in the Regional Transportation Plan. At a junction located just north of New Lechmere, the Urban Ring LRT#2 route switches from the Green Line onto the Urban Ring alignment from New Lechmere to Dudley Square.

The LRT#1 and LRT#2 routes are proposed to overlap all Urban Ring LRT stations except those located north of the Green Line Extension which are served by the LRT#1 route only. Thus, there are projected to be 18 Urban Ring trains per hour (12/LRT#1 route + 6/LRT#2 route) during the peak for all Urban Ring LRT stations, except Assembly Square and Sullivan Square that are projected to be served by 12 Urban Ring trains per hour (12/LRT#1 route) during the peak.

◦ **Alternative A2 – Heavy Rail Via Kenmore**

The following description pertains to Alternative A2. The rail element of Alternative A2 starts at Wellington (rather than Assembly Square) and its Assembly Square station is located closer to the midway point between Wellington and Sullivan Square due to use of Orange Line technology. From Sullivan Square northward to Wellington, the existing Orange Line test track would be relocated north of Wellington. This segment becomes a three-track combined Urban Ring/Orange Line operation. South of Sullivan Square, Alternative A2 follows the same alignment and has the same station locations as Alternative A1. Phase 3 of the Urban Ring includes the non-redundant conventional bus, BRT, and supporting elements of Phase 2.

Changes to Phase 2 Routes Occurring in Phase 3

BRT5 Dropped – The Rapid Transit routes provide this service

BRT2 Modified – This route is changed from Revere Beach Parkway to the busway adjacent to commuter rail.

Alternative A2 is depicted in Figure S-8. There is a single Heavy Rail Orange Line rail route in Alternative A2 as summarized below and in Tables S-3, S-4, and S-5.

Use of Orange Line vehicles in Urban Ring Alternative A2 allows the Sullivan Square, Assembly Square, and Wellington Stations to operate as joint Urban Ring/Orange Line stations served by the existing Orange Line service and the new Urban Ring Heavy Rail route. At these three stations, the proposed 4-minute headway of the Urban Ring Heavy Rail route combined with the existing Orange Line 5 minute headway provide a projected total of 27 trains/hour (15/Urban Ring Heavy Rail + 12/Existing Orange Line) in this segment, for an projected effective headway of just over 2 minutes in the peak. South of Sullivan Square to Dudley Square along the Urban Ring corridor service is provided with the single Urban Ring Heavy Rail route with proposed headways of 4 minutes in peak for a projected total of 15 trains/hour.

◦ **Alternative B – LRT Via BU/Park Drive**

The following description pertains to Alternative B. It crosses the Charles River at Cambridgeport/BU and, compared to Alternatives A1 and A2, follows a longer route with more stations needed to connect with the MBTA radial lines. Alternative B uses low-floor Light Rail Transit (LRT) technology compatible with the MBTA Green Line, and interlines with the standard Green Line Extension west of New Lechmere.

The alignment and stations of Alternative B are mostly at-grade north of the Charles River and entirely underground beneath the Charles River to Dudley Square. Alternative B in Phase 3 of the Urban Ring includes the non-redundant conventional bus, BRT, and supporting elements of Phase 2.

Changes to Phase 2 Routes Occurring in Phase 3 B

BRT5 Dropped – The LRT routes provide this service

BRT2 Modified – This route is changed from Revere Beach Parkway to the busway adjacent to commuter rail.

Alternative B is depicted in Figure S-9. There are two overlapping rail routes in Alternative B as summarized below and in Table S-3, S-4, and S-5.

Between Medford Hillside and New Lechmere the LRT2 route assumes the Green Line Extension in the Regional Transportation Plan. At a junction located just north of New Lechmere, the Urban Ring LRT#2 route switches from the Green Line onto the Urban Ring alignment from New Lechmere to Dudley Square.

The LRT#1 and LRT#2 routes are proposed to overlap all Urban Ring LRT stations, except those located north of the Green Line Extension which are served by the LRT#1 route only. Thus, there are projected to be 18 Urban Ring trains per hour (12/LRT#1 route + 6/LRT#2 route) during the peak for all Urban Ring LRT stations, except Assembly Square and Sullivan Square that are projected to be served by 12 Urban Ring trains per hour (12/LRT#1 route) during the peak.

S.7 Project Benefits and Potential Impacts

The potential impacts of each of the Urban Ring Final Alternatives were analyzed and compared to the 2025 “No Build” Alternative. The results of the analysis are summarized below organized around the major evaluation categories of transportation benefits, potential environmental impacts, economic development and land use, costs, and implementation and phasing. Tables S-10, S-11, and S-12 summarize the evaluation results for Phases 1, 2, and 3, respectively.

S.7.1 Transportation Benefits

The transportation benefits of the Urban Ring start with implementation of the new and improved bus routes in Phase 1. The benefits increase significantly with the implementation of BRT routes and supporting elements of Phase 2, and are maximized in Phase 3 with the addition of rail in the most heavily traveled portion of the Corridor. A summary of the transportation impact findings for each of the Alternatives is provided below, followed by more detailed information organized within six categories of transportation benefits.

- Alternatives A1, A2, and B are projected to have at least 290,000 boardings per day in the year 2025 for the Rail, BRT and TSM bus elements combined. By comparison, TSM in Phase 3 would have approximately 50,000 daily boardings.
- Alternatives A1, A2 and B would save travelers approximately 50,000 hours per day compared to the 2025 “No Build” Alternative. Most of those time savings would be realized by existing transit users.
- The highest Urban Ring ridership would be in the core of the Corridor between the Orange Line at Assembly Square/Sullivan Square and the Silver Line at Dudley Square. This portion of the Corridor would, for the rail and BRT routes combined, have over 200,000 boardings per day for any of the build alternatives.
- The analysis of alternatives shows that ridership would drop off significantly south of Dudley Square regardless of alignment or technology.
- Alternatives A1, A2 and B would achieve reductions in central subway congestion by providing a faster and more direct route to reach Corridor destinations by transit.

- Alternatives A1, A2 and B would serve a large number of mobility-impaired households as measured by the number of households below the poverty line (over 17,000) and households without automobiles (over 35,000) within the station catchment areas of each alternative.

Accessibility and Mobility

The accessibility of the MBTA transit system to Corridor residents and workers would be greatly increased as a result of the Urban Ring alternatives due to the location of new and improved stations closer to transit users. In addition, the accessibility to jobs and residences will be enhanced by the greatly improved connectivity of the transit system. Table S-6 contains a listing of the Urban Ring stations by phase and alternative. Table S-6, coupled with Figures S-5 through S-9, show that the Urban Ring connects with every existing and planned transit line in the MBTA system. Though not shown in the table, the Urban Ring also connects with half the local bus routes in the MBTA system providing an important feeder/distribution function by extending the reach of the higher quality Urban Ring service further into neighborhoods and employment centers.

The mobility of transit users, defined as the speed of transit trips in the system, would also be greatly improved by the Urban Ring alternatives. At a system-wide level Alternatives A1, A2, and B would save approximately 50,000 hours per day of travel time compared to the No-Build alternative. Approximately 75 percent of the daily travel-time savings would be realized by existing transit users, and the remainder by non-transit users such as autos and trucks due to fewer vehicles on the road. The projected travel-time savings are similar for each of the Phase 3 alternatives. The travel-time savings for transit users is evenly divided between in-vehicle and out-of-vehicle time. The shorter, more direct Urban Ring routes would result in less time spent within a transit vehicle to complete Corridor trips. The out-of-vehicle travel-time savings would result from the convenient accessibility of the Urban Ring LRT and BRT station stops, as well as the high frequency of service. More frequent service means less time waiting in a station for a transit vehicle to arrive. For specific trips to and from the Corridor the magnitude of the travel-time savings is even more pronounced. Seven example origin-destination pairs representing various areas of the Corridor and types of trips were analyzed to determine the travel-time savings for individual one-way transit trips. The examples include trips internal to the Corridor as well as trips to Corridor destinations from elsewhere in the Region. For both types of trips the Urban Ring would provide significant measurable travel-time savings. Out-of-vehicle waiting time in the examples was calculated as one-half the scheduled interval between arrivals of the transit vehicle. For example, if the transit vehicle is scheduled to arrive every 30 minutes the average wait time used in the calculations would be 15 minutes, if every 60 minutes the average wait would be 30 minutes, and so forth.

The analysis compared the "No-Build" trip time to the trip time that would be achieved with the Urban Ring. Table S-7 summarizes the results of this analysis for the example trips in Phase 2 as well as in Phase 3 Alternatives A1 and B. The results show dramatic improvements in transit trip times with the Urban Ring for the example trips. Example travel-time savings for Alternative A2 were not calculated, but can be expected to be similar to those of Alternative A1 for most trips due to their similar alignments and station locations. For the example origin-destination pairs, the travel-time savings are attributable to one or more of the following features of the transit system with the Urban Ring service compared to the transit system without it:

- Routing within the Corridor is more direct
- Average speed of transit vehicles is higher
- Some transfers are eliminated and others made more direct
- Frequency of service is higher
- Connections with radial transit and commuter rail enable trips to bypass downtown Boston

In Phase 2 the example travel-time savings ranged from 6 minutes to 20 minutes each way. For the Downtown Chelsea to Logan Airport example the Urban Ring Phase 2 transit travel-time savings of 20 minutes represents a 53 percent reduction in transit travel time for this trip compared to the No-Build case.

In Phase 3 the example travel-time savings ranged from 9 minutes to 28 minutes each way. For the Dudley Square, Boston to Kendall/MIT, Cambridge example the Urban Ring Phase 3 travel-time savings of 28 minutes represents a 58 percent reduction in transit travel time for this trip compared to the No-Build case.

Travel-time savings for trips to Corridor destinations from elsewhere in the region also benefit from the Urban Ring service. In Phase 2 for the Lynn to Logan Airport example the Urban Ring transit travel-time savings of nearly 13 minutes represents a 28 percent reduction in transit travel-time savings for this trip compared to the No-Build case. In this example the trip would use commuter rail from Lynn to Chelsea and transfer to the frequent Urban Ring BRT service at Chelsea for the trip to Logan Airport along a route separate from the local streets of Chelsea and East Boston.

Each of the Phase 3 alternatives would increase daily systemwide transfers by amounts ranging from 45,000 per day in Alternative A1, to 51,000 in Alternative B, and 63,000 in Alternative A2. These transfers represent approximately 6-8 percent of total systemwide transfers per day, but will be occurring primarily outside the congested central subway system.

Daily Ridership

Daily ridership on the Urban Ring is expected to be 40,000 in Phase 1 on the new and improved crosstown and express buses. Implementation of the BRT routes and improved radial connections in Phase 2 builds upon the Phase 1 services and increases total Urban Ring daily ridership to 106,000. The addition of rail transit service in Phase 3 would build ridership further to approximately 290,000, depending upon the rail transit alignment and technology chosen. Figure S-11 depicts the Urban Ring daily ridership by phase.

In Phase 3, the TSM Alternative is projected to have approximately 50,000 daily boardings in the year 2025 divided between the new Express Commuter (EC) bus routes and the new crosstown (CT) bus routes. Of the two categories, most of the ridership is associated with the CT routes, which is to be expected since the EC routes are competing with the existing and well-established radial rail lines, whereas the CT routes provide direct, limited stop service currently lacking in the crosstown travel market. Total Urban Ring daily ridership for Alternatives A1, A2 and B is expected to be substantial. While the totals are similar, the transit-mode breakdown differs. The totals are approximately 282,500 for Alternative A1; 289,350 for Alternative A2; and 293,800 for Alternative B. Refer to Table S-8 for details on daily ridership by Phase, transit mode, and route.

The Phase 3 alternatives would result in 47,000 additional linked transit person trips in the system per day compared to the 2025 No-Build. In addition to gaining substantial new transit riders, the Urban Ring alternatives would divert even larger numbers of existing transit users from other lines in the MBTA system due to superior trip times. The North and South Side Commuter Rail Lines would together experience an increase of over 17,000 riders per day compared to the 2025 No Build. These increases would be attributable to the new commuter rail stations that are part of these alternatives to facilitate easy transfer between commuter rail and the Urban Ring service. TSM alone in Phase 3 would provide a relatively minor increase in transit mode share.

Transit System Efficiency

A major problem identified during this study, as well as during previous studies, is the growing disconnect between regional and Corridor travel patterns and the existing transit system. The radial configuration of the existing transit system is not efficient or effective at serving the crosstown travel market. At each phase, the Urban Ring alternatives would progressively boost transit system efficiency by providing direct routing between transit origins and destinations that currently require transfers in the central subway system. Utilization of existing infrastructure is an important measure of efficiency, and each of the alternatives in Phase 2 and Phase 3 will make use of underutilized active and abandoned rail and roadway rights-of-way along their routes. Alternatives A1 and B would interline at New Lechmere with the planned Green Line extension to Medford Hillside enabling single seat rides between that line and the Urban Ring. Alternative A2, which uses Heavy Rail Transit, would also boost transit system efficiency because it would interline with the existing Orange Line at Sullivan Square. At Sullivan Square

Alternative A2 would utilize the existing second center platform and the existing third track (currently used for testing cars) between Sullivan Square and Wellington. Moreover, Alternative A2 could utilize the existing Wellington maintenance facility which has sufficient capacity and room for expansion to handle the Urban Ring Heavy Rail vehicles.

Transit Congestion

Transit congestion – crowding and delays in the central subway system – is a chronic problem that will be only partially addressed by capacity improvements contained in the current Regional Transportation Plan. Even with planned improvements such as using three car trains it is conservatively estimated that the Green Line will reach a demand to capacity ratio of 1.4 to 1 (40 percent over capacity) in the peak hour by the year 2025. The projected congestion on the Green Line would be even worse if the assumed 1-1/2 minute peak period headways in the central subway are lengthened due to use of three-car trains. However, with the Urban Ring, tens of thousands of daily transit trips that would otherwise be forced to pass-through the central subway would instead choose the faster and more direct Urban Ring service that bypasses downtown Boston.

Alternatives A1 and B would reduce peak hour maximum load point volumes on the Green Line down to levels 4 percent above capacity, while Alternative A2 would bring congestion down to 17 percent above capacity. Alternatives A1 and B would operate as a branch of the Green Line in tandem with the Green Line Extension to Medford Hillside, and therefore are able to divert a higher number of Green Line riders from the central subway. Congestion problems forecast for the other radial transit lines are less severe than the Green Line, though the same principle applies. The Urban Ring service would also divert transit trips from the Red Line and other radial transit lines. Removing pass-through transfers from the central subway system enables more of its limited capacity to be used for serving Downtown Boston and the radial markets. Thus, the alternatives would create new transportation capacity for the region while freeing capacity for the central subway.

Income, Auto Ownership, and Minority Populations

The number of households below the poverty level is one of the criteria used to measure Environmental Justice. Presidential Executive Order 12898, issued in 1994, directed every federal agency to make environmental justice part of its mission by identifying and addressing the effects of all programs, policies, and activities on “minority populations and low-income populations.” As such, the FTA is examining the effects that federally funded projects will have on these communities.

In support of the Executive Order, the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts (MEPA) issued a draft Environmental Justice Policy in December 2000. The public comment period for this document closed July 2, 2001 and MEPA is currently reviewing comments received from the public. It is expected that a final version will be adopted later this year.

The purpose of this policy is the support of environmental justice for all residents of Massachusetts. As a project seeking support from both the Commonwealth of Massachusetts and the FTA, the Urban Ring MIS is identifying the EJ effects of the Urban Ring. One factor measuring EJ concerns is the impact of the project on households below the poverty level.

There are large numbers of households within the station catchment areas of Alternatives A1, A2 and B that can be categorized as mobility impaired due to low-income level or lack of access to an automobile. Each of these alternatives would significantly improve transit access for such households. Based on 1990 census data, Alternative A1 station catchment areas contained 17,204 households below the poverty line and 35,314 households without an automobile. By comparison, Alternative A2 had nearly identical 17,235 households below the poverty line and 35,372 households without an automobile. Alternative B was very similar, with 17,416 and 35,755 households, respectively⁶.

⁶ The most recent Census household data on income and auto ownership is from 1990. Household data from the 2000 Census is expected to be available in 2002.

Each of the alternatives would provide access to large minority populations. Based on Year 2000 Census data there were between 115,000 and 118,000 minority residents within the catchment areas of the Urban Ring stations. Minorities represent 51 percent of the total population within these catchment areas in Year 2000.

Non-Motorized Network

The full- or partial-grade separation featured in the Phase 2 and 3 Alternatives combined with the new accessible stations that would be built under those alternatives, would result in benefits to the pedestrian and bicycle network within the Corridor compared to the TSM or "No Build" Alternatives.

S.7.2 Potential Environmental Impacts

A qualitative environmental screening was conducted for comparison purposes. Information concerning baseline environmental conditions within the Corridor was developed and used to assess the potential impact of each Evaluation Alternative relative to the following subject areas:

- Air quality
- Noise and vibration
- Historic resources
- Archeological resources
- Parkland/open space resources
- Wetland resources
- Hazardous materials

As the range of alternatives narrowed, more detailed information became available from the Central Transportation Planning Staff model regarding change in vehicle miles traveled (VMT) and the associated air quality impacts. Additionally, concerns regarding the potential impacts of noise, vibration and electromagnetic fields were raised regarding the portions of the alignments adjacent to laboratories, particularly along the Grand Junction alignment through the MIT campus.

Each of the Evaluation Alternatives is projected to result in a major decrease in regional VMT compared to the No-Build alternative due to the increased attractiveness of public transit versus automobile travel. The TSM Alternative would decrease VMT by only 8,100 per day, while the three build alternatives would each result in a decrease of over 350,000 VMT per day.

Each of the build alternatives would result in a significant improvement in air quality by achieving a substantial reduction in emissions as summarized in Table S-9.

Other than temporary construction period impacts, the only potentially serious long-term environmental impacts associated with the Final Alternatives are the noise and vibration impacts of Phase 2 and 3, and the electromagnetic field interference of the Phase 3 rail alternatives. A more detailed analysis of these potential impacts was performed and is summarized herein.

Electromagnetic Field Interference

There are no EMI impacts associated with Phases 1 or 2 because they do not utilize electrically powered vehicles. In Phase 3, the Urban Ring project would use transit vehicles powered by electric traction motors. The electric supply lines (600 volts DC) provide peak currents of 4,500 amps for light rail vehicles and 7,000 amps for heavy rail. These lines have the potential for producing EMI detectable within the 11 sensitive facilities and laboratories and other buildings bordering the proposed route(s) in East Cambridge. The key determinants of electromagnetic field interference (EMI) of rail transit are: magnitude of electric currents and voltages utilized by the train; proximity of sensitive receptors to rail line; pattern of current and voltage time variation; spatial configuration of the conductors supplying electric power; the frequency of rail traffic; and the degree of EMI isolation required by sensitive receptors. The

highest EMF (~1,570 milliGauss) is expected at close range (15 feet away) from Alternative B is approximately three times the earth's magnetic field which ranges in strength from about 470 mG to 590 mG over North America. In Phase 3, the highest potential EMI impacts are associated with Alternative B, the second highest potential impact would be with Alternative A1, and the lowest potential impact of the three would be Alternative A2 due to its power source (third rail) being the furthest from the sensitive receptors.

The EMI associated with Phase 3 Alternatives A1, A2, and B could be reduced by mitigation at the source and/or mitigation at the receptor. Mitigation at the source may require design measures prior to construction that ensure that electric-current conductors to and from the LRT or heavy-rail vehicles travel as close to each other as feasible and minimize sneak current paths, *i.e.*, assuring that the supply and return currents are of equal magnitude. Mitigation using current-path alignment has been used by the MBTA in other situations, and can achieve several-fold attenuation, depending upon details of current paths before and after alignment. Mitigation at the receptor location, such as placing high-permeability ferromagnetic "mu-metal" sheets in locations that shunt the magnetic field lines away from sensitive areas can be laboratory-specific, can be undertaken after operation begins, and can be implemented on an "as-needed" basis. Magnetic shielding is a common approach already used by many laboratories doing sensitive measurements in electrically noisy environments. Another mitigation method involves electronic detection of the interfering field and generation of a canceling magnetic field that counteracts the EMI at the location that must be protected from interference. This active electronic method has been used successfully in situations where power-line fields have caused problems, but it is both expensive and maintenance-intensive.

In summary, Alternative B has the highest potential EMF/EMI impacts and would be the most difficult and expensive to mitigate. Alternatives A1 and A2 in tunnel have fewer impacts due to greater distance from receptors offered by the tunnel alignment compared to the surface alignment of Alternative B. Moreover, the alignment of A1 and A2 curves away from the receptors starting west of Massachusetts Avenue, whereas the alignment of Alternative B extends all the way to Cambridgeport. The Vassar Street alignment option, only available with Alternatives A1 and A2, provides further physical separation from the sensitive receptors compared to the Grand Junction alignment.

Noise and Vibration

There is unlikely to be any noise and vibration impact in Phase 1 because there is no major construction and the proposed bus routes use existing streets and use conventional bus technology. Therefore, the analysis focused on potential impacts in Phases 2 and 3 in the area along the existing Grand Junction Rail Corridor in East Cambridge west of Main Street. Many of the facilities along this corridor are part of the Massachusetts Institute of Technology as well as other public and private institutions and businesses. This corridor also includes a number of MIT laboratories with vibration sensitive equipment. The alternatives under consideration along this section of the Urban Ring corridor include a dedicated BRT busway, an underground rapid transit or light rail system, or an at-grade light rail system. The noise and vibration assessment was performed in accordance with the Federal Transit Administration's (FTA) guidelines contained in their "Transit Noise and Vibration Impact Assessment" manual.

BRT Busway:

The BRT busway alternative will consist of a paved dedicated roadway for CNG powered 60-foot long articulated buses traveling within the existing Grand Junction Rail Corridor. Because the buses are rubber tired vehicles, the vibration levels associated with the bus passbys are not expected to generate vibration impacts along the proposed BRT alignment. The bus operations along the busway and idling at the stations could result in noise impacts at the existing and proposed residential and student housing along the BRT alignment. As mitigation, sound insulation consisting of double or triple glazed windows could be installed to provide the necessary noise reduction for these dormitory rooms. The Vassar Street BRT routing option would be less likely to cause a significant change in existing noise and vibration levels because it is currently used by the existing CT2 bus route.

Alternatives A1 and A2 - Underground Rail Beneath the Grand Junction Railroad

The underground rail alignment option beneath the Grand Junction Rail Corridor would result in essentially no noise impact at sensitive receptor locations along the corridor. However, using the FTA's Category 1 vibration criteria for buildings where low ambient vibration is essential for the operation of sensitive equipment, vibration impacts could occur at several of the MIT laboratories along Vassar Street and Albany Street that have been identified as having vibration sensitive equipment. To mitigate these vibration levels, ballast mats could be installed under the tracks in the vicinity of these buildings.

Alternatives A1 and A2 - Underground Rail Beneath Vassar Street

The underground rail alignment option beneath Vassar Street would also result in essentially no noise impact at sensitive receptor locations along the corridor. However, vibration impacts could occur at several of the MIT laboratories along Vassar Street that have been identified as having vibration sensitive equipment. To mitigate these vibration levels, ballast mats could be installed under the tracks in the vicinity of these buildings. The MIT laboratories along Albany Street are further away from this alignment and are less likely to be impacted by vibration from train passbys.

Alternative B - Light Rail At-Grade

The at-grade light rail alignment along the Grand Junction Rail Corridor would result in noise impacts along the corridor. In accordance with FTA guidelines, a number of "severe" noise impacts are expected to occur because of the wheel squeal generated by LRT passbys along the two tight curves located in the Kendall Square area of the alignment. In order to eliminate this wheel squeal, the turning radius of the rail alignment would need to be greater than 1000 feet which is not feasible given the street layout and location of existing buildings. Noise impacts will also occur at the existing and proposed residential and student housing along the rail corridor. As a result, sound insulation consisting of double or triple glazed windows could be installed to provide the necessary noise reduction for these dormitory rooms. Vibration impacts could occur at several of the MIT laboratories along Vassar Street and Albany Street that have been identified as having vibration sensitive equipment. To mitigate these vibration levels, ballast mats could be installed under the tracks in the vicinity of these buildings.

In summary, the noise and vibration impacts of the Grand Junction alignments would have a greater potential impact on facilities than would the Vassar Street alignment because the Vassar Street alignment provides greater physical distance from more of the sensitive receptors compared to the Grand Junction alignment.

S.7.3 Land Use and Economic Development

Early in the study process, the Compact communities were asked to identify the locations where they desired and expected development to occur. Figure S-10 illustrates these 77 economic target zones. The Urban Ring "Build" Alternatives would improve transit access to approximately 85 percent of these areas, as measured by the proximity of Urban Ring stations to those target areas. Aside from the larger station catchment area⁷ assumed for LRT compared to BRT, there is relatively little difference among the Build Alternatives in their ability to service economic target areas, or in the demographics around the proposed station locations.

Employment and population served are similar for all the Alternatives. Alternative B shows totals somewhat higher than Alternatives A1 and A2 primarily because it takes a longer route covering a larger geographic area. Nevertheless, the demographics are all within 5 percent of each other for the three alternatives.

The residential population around the Urban Ring stations is 52 percent minority and contains large numbers of low income households and households without automobiles.

⁷ Demographic totals based on catchment area of 1/2-mile radius around LRT stations and 1/3-mile radius around BRT stations, which is based on guidelines established by CTPS to reflect the typical distance a transit user is willing to walk to reach a station.

The Urban Ring Compact jurisdictions believe that growth within certain areas of the Corridor is likely to exceed the forecasts presented above which were prepared within Regional control totals and assume the 2025 "No Build" condition. The Urban Ring Compact has prepared a companion report addressing in greater detail its vision of the relationship between the transportation alternatives and land use and economic development within the Corridor.

S.7.4 Costs

Capital Costs

All costs are expressed in 2001 constant dollars exclusive of debt service. The magnitude capital costs of the alternatives with a 50 percent contingency on construction and including design and construction management, administration and insurance are summarized below. The capital costs shown for each phase are additive to the previous phase as shown in the cumulative column below. The Phase 1 and Phase 2 costs are common to each of the Phase 3 alternatives.

	<u>Phase</u>	<u>Cumulative</u>
Phase 1:	\$100 million	\$100 million
Phase 2:	\$500 million	\$600 million
Phase 3A1:	\$2.3 billion	\$2.9 billion
Phase 3A2:	\$2.2 billion	\$2.8 billion
Phase 3B:	\$2.2 billion	\$2.9 billion

Operation and Maintenance Costs

Operating statistics for the final alternatives were prepared by the Central Transportation Planning Staff (CTPS) in May 2001. An estimate of the number of days that each transit mode will operate in the Urban Ring in a standard year was taken from the MBTA's 1998 National Transit Database along with the cost model factors for each transit mode. Cost model factors were then applied to the operating statistics, and estimated annual operating and maintenance costs were developed. The total annual operating costs of the Alternatives at the full implementation of each Phase are shown below in Year 2001 constant dollars. For Phase 2 and 3 a breakdown of the O&M cost by mode is shown in parentheses.

Phase 1:	\$23 million/yr.
Phase 2:	\$31 million/yr. (\$10.5M bus + \$20.5M BRT = \$31M)
Phase 3A1:	\$56 million/yr. (\$14M bus + \$19M BRT + \$23M LRT = \$56M)
Phase 3A2:	\$55 million/yr. (\$14M bus + \$19M BRT + \$22M Heavy Rail = \$55M)
Phase 3B:	\$56 million/yr. (\$12M bus + \$19M BRT + \$25M LRT = \$56M)

Due to the significant capital, operating, maintenance, and debt service costs associated with the Final Alternatives, as well as the competitive environment for federal and state funding, the MIS has begun to examine a wide range of innovative funding concepts for possible application to the Urban Ring. The examination of innovative funding mechanisms for Phases 2 and 3 will continue following the MIS Final Report. Cost effectiveness indices for each of the phases will be determined during the DEIR/DEIS process, using the new Federal Transit Administration formulas that are expected to become available in September 2001.

S.7.5 Phasing and Implementation

The Urban Ring alternatives exhibit very good phasing characteristics because they can be built incrementally over time, the phases are separable, and the choices in Phases 1 and 2 can be made while retaining the flexibility to choose any of the Phase 3 rail transit alternatives. Phase 1 is the easiest to implement because it is low cost and involves no new right-of-way or technology. In Phase 1, two of the new CT bus routes show very strong ridership demand and could be considered for early phased implementation. Those routes are:

- CT5 Logan Airport to Sullivan Square (6,360 riders per day)

- CT7 Kendall Square to Franklin Park Zoo (4,940 riders per day)

During Phase 1 implementation of the new and improved CT and EC bus routes can be accomplished within the established MBTA service planning cycle without the need for an environmental process. Phase 2, which involves construction of new transportation facilities, modification of existing facilities, and implementation of major new transportation services, will be subject to a coordinated state and federal environmental review process. Sometime following implementation of the Phase 2 Urban Ring services a coordinated state and federal environmental process will be conducted for Phase 3 of the Urban Ring during which a determination on the preferred alignment and technology would be made.

S.8 Next Steps

The next steps to take place concurrent with and following completion of the Major Investment Study of transportation improvements in the Urban Ring Corridor include and filing of an Expanded ENF for the project:

- Submit an Expanded ENF for MEPA review and establish the special review procedures;
- Conduct a coordinated State (MEPA) and Federal (FTA/NEPA) review;
- Prioritize the recommended Phase 1 bus routes through the MBTA service planning process;
- Secure funding for rolling stock and operating costs for the Phase 1 bus routes;
- Define the scope, schedule, and budget to complete the DEIR/DEIS for the Phase 2 system;
- Secure funding for design and construction of facilities, procurement of rolling stock, and operating costs of the Phase 2 system;
- Continue the public outreach and project reporting process.

The Working Committee, its Subcommittees and the Compact municipalities will continue to be active participants throughout completion of the MIS, underscoring the strong grassroots support and close coordination of transportation and land use planning that are the hallmarks of the Urban Ring project.

**Table S-1
Phase I Urban Ring Bus Routes**

Type	Name	End Points		Number of Stops	Length
Express ¹	EC1	Woburn Intermodal	Kendall/MIT	4	14 mi.
	EC2	Riverside	Lechmere	6	14 mi.
	EC3	Route 9 Natick	Kenmore	6	24 mi.
Crosstown ^{2, 3}	CT1	Central Square	Andrew	10	4 mi.
	CT2	Sullivan Square	Longwood/LMA	11	6 mi.
	CT3	Longwood/LMA	Logan Airport ⁴	8	8 mi.
	CT4	Ruggles	UMass Campus ⁴	5	5 mi.
	CT5	Logan Airport	Sullivan Square	12	8 mi.
	CT6	Chelsea Downtown	Kendall/MIT	3	5 mi.
	CT7	Kendall/MIT	Franklin Park	11	7 mi.
	CT8	Sullivan Square	Longwood/LMA	7	5 mi.
	CT9	Kenmore	Harvard Square	5	5 mi.
	CT10	Kenmore	JFK/UMass	8	5 mi.
	CT11	Longwood/LMA	Fields Corner	9	6 mi.

¹ EC routes to operate similar to existing MBTA Express Bus service with 12-minute headways including reverse direction service.

² CT routes to operate similar to existing MBTA Crosstown (CT) limited-stop service connecting rapid transit nodes and major activity centers with 10-minute peak period headways and 20-minute off-peak headways.

³ CT1, CT2, CT3 are modifications to existing routes. All other routes shown are new

⁴ In Phase 1 the proposed CT3, CT4 and CT5 routes would serve locations currently served by non-MBTA shuttle bus operators. Implementation of Phase 1 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors. Location of existing private shuttle operation.

Table S-2
Phase 2 Urban Ring Bus Rapid Transit (BRT) Routes

Type	Name	End Points		Number of Stations	Length
Bus Rapid Transit	BRT1	Logan Airport ¹	Kendall/MIT	14	10 mi.
	BRT2	Logan Airport ¹	Wellington	5	6 mi.
	BRT3	Wellington	Kendall/MIT	6	5 mi.
	BRT4	Riverside	Kendall/MIT	7	11 mi.
	BRT5	New Lechmere	Longwood/LMA	10	4 mi.
	BRT6	Longwood/LMA	UMass Campus ¹	11	6 mi.
	BRT7	Longwood Medical Area	Logan Airport ¹	8	8 mi.

Table S-3
Phase 3 Urban Ring Rail Routes - By Alternative

Alternative	Name	End Points		Number of Stations	Length
A1 Light Rail Via Kenmore	LRT1	Assembly Square	Dudley Square	10	6.0 mi.
	LRT2	Medford Hillside	Dudley Square	13	9.3 mi.
A2 Heavy Rail Via Kenmore	HRT	Wellington	Dudley Square	11	6.8 mi.
B Light Rail Via BU/Park Dr.	LRT1	Assembly Square	Dudley Square	14	6.8 mi.
	LRT2	Medford Hillside	Dudley Square	17	9.6 mi.

¹ In Phase 2 the proposed BRT1, BRT2 and BRT6 routes would serve locations currently served by non-MBTA shuttle bus operators. Implementation of Phase 2 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors to the extent that they have not already been resolved in Phase 1.

**Table S-4
Features By Phase**

Feature	Phase 1 Transportation System Management Improved Bus Service	Phase 2 Bus Rapid Transit (BRT)	Phase 3 Rail Service A1, A2, B
Time Frame	Years 0-5 from MIS	Years 6-10 from MIS	Years 11-15 from MIS
Technology	40 Foot Low-Emission Buses Modified Existing Crosstown Routes New Crosstown Routes New Express Bus Service	60 Foot Articulated CNG Low-Floor Technology with signal priority, ITS, Commuter Rail interfaces, passenger amenities, and segments of separate r-o-w New and improved commuter rail stations	New Rail Service (Light Rail or Heavy Rail) Supplements Existing Rail Service
Construction	None (uses existing infrastructure)	New and modified roadways, busways, intersection improvements and modified or new commuter rail stations	New rail track, structures, tunnel Under Charles River, stations, and new or expanded maintenance facility
Vehicles	100 low floor 40' CNG buses (75 service + 25 spares)	[Approximately half of Phase 1 bus routes continue to operate using buses purchased in Phase 1] 80 low floor 60' CNG BRT buses (53 service + 27 spares)	[Approximately half of Phase 1 bus routes continue to operate using buses purchased in Phase 1] [Six of the seven Phase 2 BRT routes continue to operate using BRT vehicles purchased in Phase 2] 80 LRT or Heavy Rail vehicles (70 service + 10 spares)

**Table S-5
Service Frequency By Phase**

Period	Headway in Minutes				
	Phase 1	Phase 2	Phase 3 - Rail		
	Bus	BRT	Alternative A1	Alternative A2	Alternative B
Peak Morning/Peak Evening	10	10	3.3 *	4	3.3 *
Midday/Saturdays	20	15	7.5 **	10	7.5 **
Sundays/Holidays/Evening	20	20	10 ***	15	10 ***

* Effective headway of two overlapping light rail routes, one with 5 minute headway, one with 10 minute.

** Effective headway of two overlapping light rail routes, each with 15 minute headways.

*** Effective headway of two overlapping light rail routes, each with 20 minute headways.

Table S-6
List of Stations by Phase and Service

STATION	LOCATION	CONNECTIONS		Urban Ring Service			
		Commuter	Transit	Type	PHASE 2	PHASE 3	PHASE 3
		Rail				A	B
Logan Terminals ¹	Boston			BRT	•	•	•
Airport Blue Line	Boston		BLUE	BRT	•	•	•
Chelsea Commuter Rail ²	Chelsea	New/Rockport		BRT	•	•	•
Everett Avenue / Mystic Mall	Chelsea			BRT	•	•	•
Revere Beach Parkway	Everett			BRT	•	•	•
Second Street	Everett			BRT	•	•	•
Broadway	Everett			BRT	•	•	•
Wellington	Medford		ORANGE	BRT	•	•	•
Wellington	Medford		ORANGE	RAIL		A2	
Assembly Square	Somerville			BRT	•	•	•
Assembly Square	Somerville			RAIL		•	•
Gilman Square	Somerville	Lowell	GREEN	BRT	•	•	•
Union Square	Somerville	Fitchburg		BRT	•	•	•
Sullivan Square	Boston	New/Rockport, Haverhill	ORANGE	BRT	•	•	•
Sullivan Square	Boston	New/Rockport, Haverhill	ORANGE	BRT		•	•
New Washington St.	Somerville			BRT	•	•	•
New Washington St.	Somerville			RAIL			•
Community College	Boston		ORANGE	BRT	•	•	•
Fitchburg St.	Somerville			RAIL			•
New Lechmere	Cambridge		GREEN	RAIL		•	•
New Lechmere	Cambridge		GREEN	BRT	•	•	•
First Street / Galleria	Cambridge			BRT	•	•	•
Kendall Square	Cambridge		RED	RAIL		•	•
Kendall Square	Cambridge		RED	BRT	•	•	•
MIT / Mass Avenue	Cambridge			RAIL		•	•
MIT / Mass Avenue	Cambridge			BRT	•	•	•
Cambridgeport	Cambridge			RAIL			•
Cambridgeport	Cambridge			BRT	•	•	•
BU / St. Mary's	Boston	Framingham/Worcester		RAIL			•
BU / St. Mary's	Boston		GREEN	BRT	•	•	•
Kenmore / Yawkey	Boston	Framingham/Worcester	GREEN	RAIL		•	
Kenmore / Yawkey	Boston	Framingham/Worcester	GREEN	BRT	•	•	•
Fenway	Boston		GREEN	RAIL		•	•
Fenway	Boston		GREEN	BRT	•	•	•
Longwood / Pasteur	Boston			RAIL		•	•
Longwood / Pasteur	Boston			BRT	•	•	•
Huntington Avenue	Boston		GREEN	BRT	•	•	•
Ruggles	Boston	Franklin /Stoughton	ORANGE	RAIL		•	•
Ruggles	Boston	Franklin /Stoughton	ORANGE	BRT	•	•	•
Dudley Square	Boston		SILVER	RAIL		•	•
Washington St. / Silver Line	Boston		SILVER	BRT	•	•	•
Boston Medical Center	Boston			BRT	•	•	•
Blue Hill Avenue	Boston			BRT	•	•	•
Uphams Corner	Boston	Readville		BRT	•	•	•
Edward Everett Square	Boston			BRT	•	•	•
JFK / UMass	Boston	Old Colony	RED	BRT	•	•	•
UMass Campus ¹	Boston			BRT	•	•	•
Crosstown / Albany	Boston			BRT	•	•	•
Biosquare	Boston			BRT	•	•	•
Convention Center	Boston			BRT	•	•	•

¹ Location of existing private shuttle operation. Refer to paragraphs S.6.5.1 and S.6.5.2 for discussion of issues.

² A BRT station near the corner of Eastern Avenue in Chelsea is recommended, though not shown in this table.

Table S- 7
Travel Time Savings For Example Origin/Destination Pairs - Urban Ring Compared to No-Build by Phase

PHASE 2		No Bld 2010			BRT 2010			Travel Time Savings		
origin	destination	before			after					
		in-veh	out-veh	total	in-veh	out-veh	total	in-veh	out-veh	total
Assembly Sq	U Park/MIT	19.00	20.00	39.00	17.25	13.40	30.65	1.75	6.60	8.35
Dudley	Kendall	24.30	23.00	47.30	22.50	15.00	37.50	1.80	8.00	9.80
Alewife	Fenway	24.60	19.42	44.02	21.18	17.00	38.18	3.42	2.42	5.84
Lynn	Logan Airport	30.00	16.00	46.00	18.60	14.50	33.10	11.40	1.50	12.90
Uphams Corner	Boston Med Ctr.	14.00	15.00	29.00	9.50	8.10	17.60	4.50	6.90	11.40
Ruggles	Umass Campus	33.00	11.50	44.50	26.50	8.50	35.00	6.50	3.00	9.50
DT Chelsea	Logan Airport	18.50	19.00	37.50	11.39	6.00	17.39	7.11	13.00	20.11
PHASE 3		No Bld 2025			Alt A1 - 2025			Travel Time Savings		
origin	destination	before			after					
		in-veh	out-veh	total	in-veh	out-veh	total	in-veh	out-veh	total
Assembly Sq	U Park/MIT	19.10	20.00	39.10	11.08	9.50	20.58	8.02	10.50	18.52
Dudley	Kendall	25.30	23.00	48.30	13.00	7.20	20.20	12.30	15.80	28.10
Alewife	Fenway	25.60	17.00	42.60	18.70	11.50	30.20	6.90	5.50	12.40
Lynn	Logan	32.00	16.00	48.00	19.60	14.50	34.10	12.40	1.50	13.90
Uphams Corner	Boston Med Ctr.	15.00	15.00	30.00	9.91	8.00	17.91	5.09	7.00	12.09
Ruggles	Umass Campus	34.00	11.50	45.50	27.70	8.50	36.20	6.30	3.00	9.30
DT Chelsea	Logan Airport	18.50	19.00	37.50	11.40	6.00	17.40	7.10	13.00	20.10
PHASE 3		No Bld 2025			Alt B - 2025			Travel Time Savings		
origin	destination	before			after					
		in-veh	out-veh	total	in-veh	out-veh	total	in-veh	out-veh	total
Assembly Sq	U Park/MIT	19.10	20.00	39.10	12.70	9.50	21.80	6.40	10.90	17.30
Dudley	Kendall	25.30	23.00	48.30	13.30	7.20	20.50	12.00	15.80	27.80
Alewife	Fenway	25.60	17.00	42.60	20.85	11.40	32.25	4.75	5.60	10.35
Lynn	Logan	32.00	16.00	48.00	19.60	14.50	34.10	12.40	1.50	13.90
Uphams Corner	Boston Med Ctr	15.00	15.00	30.00	9.91	8.00	17.91	5.09	7.00	12.09
Ruggles	Umass Campus	34.00	11.50	45.50	27.70	8.50	36.20	6.30	3.00	9.30
DT Chelsea	Logan Airport	18.50	19.00	37.50	11.40	6.00	17.40	7.10	13.00	20.10

Source: CTPS June 2001

Notes: Numbers shown are in minutes and fractions of minutes for single one-way trip in AM peak period.

Time savings for Alternative A2 not shown would be the same or greater than those shown for Alternative A1.

The Logan Airport and UMass locations are currently served by private shuttle operations. Refer to paragraphs S.6.5.1 and S.6.5.2 for discussion of issues to be resolved.

Table S- 8
Daily Ridership on the Urban Ring Services

Route*	Route Description	TSM			BRT	Rail (Kenmore)		Rail (BU)
						A1	A2	B
		Phase 1 2003 TSM	Phase 2 2010 TSM	Phase 3 2025 TSM	Phase 2 2010 TSM+BRT	Phase 3 2025 TSM+BRT+LRT	Phase 3 2025 TSM+BRT+HRT	Phase 3 2025 TSM+BRT+LRT
EC1	Woburn/Mishawum - University Park	3,550	4100	4,350				
EC2	Lechmere - Riverside	1,600	1,950	2,150	1,600	1,700	1,800	1,650
EC3	Kenmore - Rt. 9 Natick	430		550	500	400	400	250
	EC Total	5,580	6,050	7,050	2,100	2,100	2,200	1,900
CT1	Central Square - Andrew	3,500	3,250	3,800	2,950	2,100	2,200	2,650
CT2	Sullivan Square - Longwood Med. Area	4,470	5,850	5,300		400	400	
CT3	Longwood Med Area/ Airport Blue Line Sta.	1,100	900	1,500				
CT4	Ruggles - UMass	1,120	1,000	1,200				
CT5	Logan Airport - Sullivan Square	6,360	8,400	10,200				
CT6	Bellingham/Chelsea Comm. Rail - Kendall	2,080	2,850	750	400	100	100	100
CT7	Kendall Square - Franklin Park Zoo	4,940	5,550	7,000	6,550	700	700	5,230
CT8	Sullivan Square - Longwood Med. Area	3,380	3,750	3,450				
CT9	Kenmore - Harvard Square	2,500	2,900	3,000	2,650	5,150	5,000	4,400
CT10	Kenmore - JFK/UMass	3,000	2,800	4,000	2,800	1,550	1,600	1,650
CT11	Longwood Med Area - Fields Corner	2,270	2,250	2,400	3,800	4,700	4,900	5,850
	CT Total	34,720	39,500	42,600	19,150	14,700	14,900	19,880
BRT1	Logan Airport - Kendall Square				34,300	31,500	31,300	29,970
BRT2	Logan Airport - Wellington				11,900	10,800	12,100	10,800
BRT3	Wellington - Kendall Square				8,850	7,100	10,000	5,450
BRT4	Riverside - Kendall Square				9,650	4,850	5,100	3,100
BRT5	New Lechmere - Longwood Med. Area				11,300			
BRT6	Longwood Med Area - UMass				4,850	5,000	4,900	4,800
BRT7	Longwood Med Area/Airport Blue Line Sta.				3,900	2,600	2,550	2,600
	BRT Total				84,750	61,850	65,950	56,720
LRT1	Assembly Square - Dudley Square					107,350		129,400
LRT2	Medford Hill Side - Dudley Square					96,500		85,900
HRT1	Wellington - Dudley Square						206,300	
	LRT/HRT Total					203,850	206,300	215,300
	TOTAL – ALL ROUTES	40,300	45,550	49,650	106,000	282,500	289,350	293,800

Route name denotation:

ec: Express Commuter Bus

EC: Crosstown Bus

BRT: Bus Rapid Transit

LRT: Light Rail Transit

HRT: Rapid Transit

Note: The Logan Airport and UMass locations are currently served by private shuttle operations. In Phase 1 the proposed CT3, CT4 and CT5 routes would serve these locations. Implementation of Phase 1 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors. In Phase 2 the proposed BRT1, BRT2 and BRT6 routes would serve locations currently served by non-MBTA shuttle bus operators. Implementation of Phase 2 service in such locations will be need to address issues of vehicle purchase, operating subsidy, 13(c) indemnification, and indemnification of competition claims from current shuttle contractors to the extent that they have not already been resolved in Phase 1.

Source: CTPS

Table S-9

Air Quality Impacts of the Urban Ring Evaluation Alternatives Compared to the No-Build Case

Effect*	TSM			BRT	Rail (Kenmore Alignment)		Rail (BU Alignment)
	Phase 1 2003	Phase 2 2010	Phase 3 2025	Phase 2 2010 TSM+BRT	Phase 3, Alt. A1 2025 TSM+BRT+LRT	Phase 3, Alt. A2 2025 TSM+BRT+RTL	Phase 3, Alt. B 2025 TSM+BRT+LRT
VMТ** Reduction	14,150	4,500	8,100	52,500	355,200	384,200	369,600
VOC Reduction (kg/day)	12	3	5	39	468	475	467
CO Reduction (kg/day)	140	37	48	435	6,360	6,355	6,237
NOx Reduction (kg/day)	18	5	7	76	544	578	560
CO₂ Reduction (kg/day)	6,889	2,191	3,944	25,561	172,941	187,061	179,952
Methane Reduction (kg/day)	0.8	0.2	0.4	2.9	19.2	20.7	20.0

* Relative to the No Build base case.

** Vehicle miles traveled.

Table S- 10

Phase 1 - Summary Results

Criteria	TSM ¹
Transportation Accessibility - Travel Time Savings Average Daily - Systemwide Transfers - Network Connectivity Daily Ridership - Urban Ring Total - Systemwide Change - Mode Share Change Transit System Efficiency Transit Congestion Relief Access for Mobility Impaired Non-Motorized Access	3,870 hrs. +150/day Fair 40,300 +6,600 +0.04 Good Good Good Good
Environment Air Quality Improvement Noise/Vibration/EMF Impact Wetlands Impact Low Income/Minority Access Daily VMT Change Auto Person Trips Change	Good Low None Good -14,150 -3,700
Land Use/Economic Development Consistency with Local, State, Regional & Federal Goals Urban Fabric Benefits Transit Supportive Land Use Transit Supportive Economics	Good Fair Fair Fair
Cost² Capital Costs O & M Costs	 \$100 M \$23 M/yr.
Implementation and Phasing Characteristics	Excellent

¹ All comparisons are to the 2003 No-Build Alternative.

² Capital and O&M costs shown are exclusive of debt service and are in 2001 constant dollars. O&M costs are based on full implementation of all proposed Phase 1 CT and EC routes. However, not all Phase 1 routes would be implemented by 2003.

Table S-11

Phase 2 - Summary Results

Criteria	Alternatives ¹	
	TSM ²	BRT ³
Transportation Accessibility - Travel Time Savings Average Daily - Systemwide Transfers - Network Connectivity Daily Ridership - Urban Ring Total - Systemwide Change - Mode Share Change Transit System Efficiency Transit Congestion Relief Access for Mobility Impaired Non-Motorized Access	 1,404 hrs. -1,000/day Fair 45,550 +1,850 +0.01 Good Good Good Good	 17,117 hrs. -7,550/day Very Good 106,000 +15,000 +0.09 Very Good Good Very Good Good
Environment Air Quality Improvement Noise/Vibration/EMF Impact Wetlands Impact Low Income/Minority Access Daily VMT Change Auto Person Trips Change	 Good Low None Good -4,500 -1,100	 Very Good Medium Medium Very Good -52,500 -13,150
Land Use/Economic Development Consistency with Local, State, Regional & Federal Goals Urban Fabric Benefits Transit Supportive Land Use Transit Supportive Economics	 Good Fair Fair Fair	 Very Good Very Good Very Good Very Good
Cost ⁴ Capital Costs O & M Costs	 \$0 \$23 M/yr.	 \$500 M \$32 M/yr.
Implementation and Phasing Characteristics	Excellent	Very Good

¹ All comparisons are to the 2010 No-Build Alternative.

² The alternative consists of the Phase 1 alternative in 2010.

³ The BRT alternative consists of BRT + Supporting Elements + non-redundant Phase 1 TSM combined in 2010.

⁴ Capital and O&M costs shown are exclusive of debt service and are in 2001 constant dollars. O&M costs for the BRT alternative are based on full implementation of all Phase 2 BRT routes and includes operation of non-redundant TSM bus routes. There is no capital cost for TSM buses in Phase 2 because they were purchased in Phase 1.

Table S-12

Phase 3 - Summary Results

Criteria	Alternatives ¹			
	TSM ²	A1 ³	A2	B
Transportation				
Accessibility				
• Travel Time Savings	2,829 hrs.	49,186 hrs.	51,186 hrs.	50,217 hrs.
Average Daily				
• Systemwide Transfers	+7,250/day	+45,700/day	+63,050/day	+51,000/day
• Network Connectivity	Fair	Excellent	Excellent	Excellent
Daily Ridership				
• Urban Ring Total	49,650	282,500	289,350	293,800
• Systemwide Change	+5,500	+46,500	+46,400	+47,650
• Mode Share Change	+0.04	+0.27	+0.27	+0.28
Transit System Efficiency	Good	Excellent	Excellent	Excellent
Transit Congestion Relief	Good	Excellent	Excellent	Excellent
Access for Mobility Impaired	Good	Very Good	Excellent	Very Good
Non-Motorized Access	Good	Excellent	Excellent	Excellent
Environment				
Air Quality Improvement	Good	Excellent	Excellent	Excellent
Noise/Vibration/EMF Impact	None	Medium	Medium	High
Wetlands Impact	Low	Low	Low	Low
Low Income/Minority Access	Good	Very Good	Very Good	Very Good
Daily VMT Change	-8,100	-355,200	-384,200	-369,600
Auto Person Trips Change	-2,000	-37,900	-38,700	-39,050
Land Use/Economic Development				
Consistency with Local, State, Regional & Federal Goals	Good	Excellent	Excellent	Excellent
Urban Fabric Benefits	Fair	Excellent	Excellent	Excellent
Transit Supportive Land Use	Fair	Excellent	Excellent	Excellent
Transit Supportive Economics	Fair	Excellent	Excellent	Excellent
Cost ⁴				
Capital Costs	\$0	\$2.3 B	\$2.2 B	\$2.2 B
O & M Costs	\$23 M/yr.	\$56 M/yr.	\$55 M/yr.	\$56 M/yr.
Implementation and Phasing Characteristics	Excellent	Good	Good	Good

¹ All comparisons are to the 2025 No-Build Alternative.

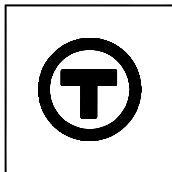
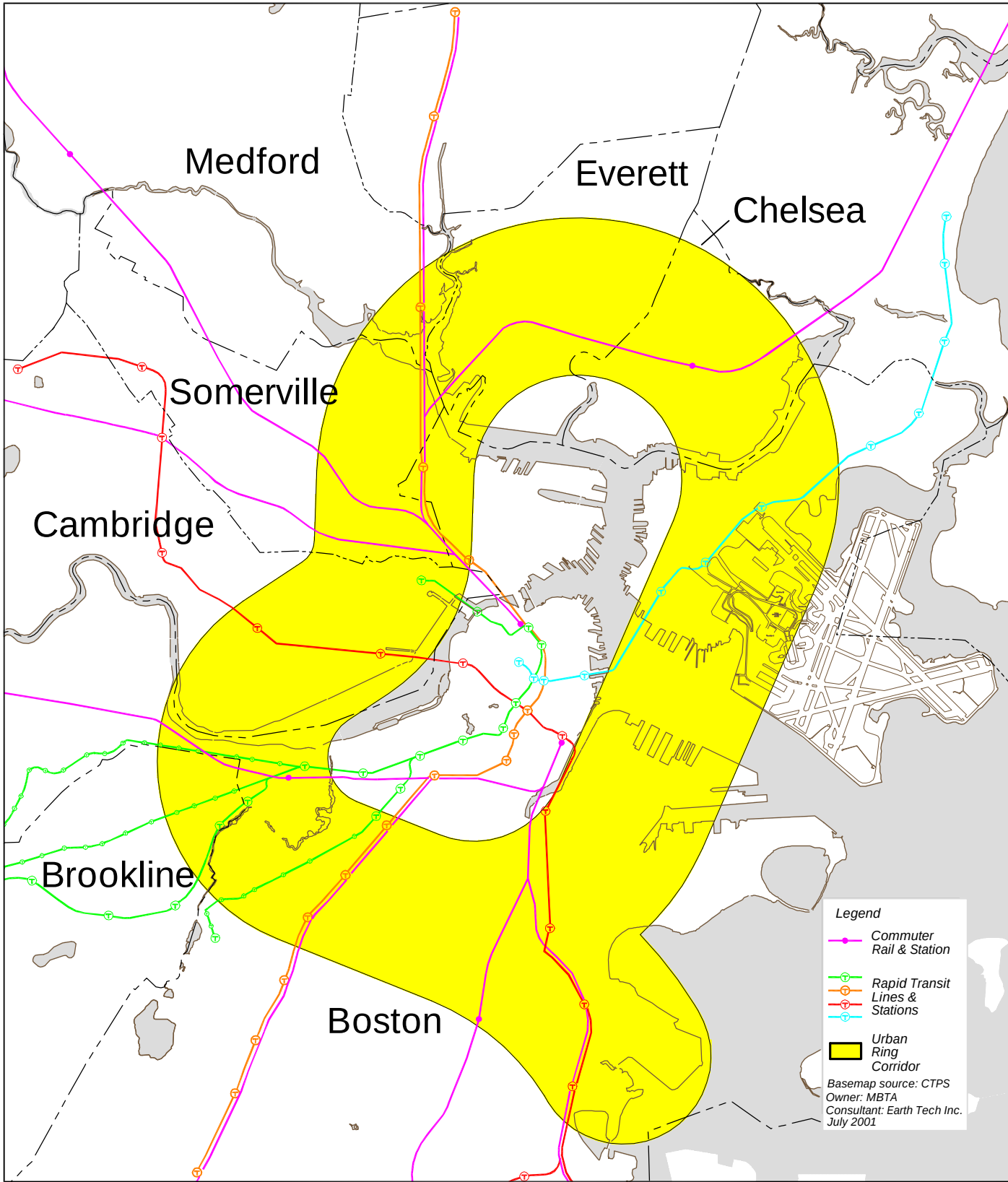
² The alternative consists of the Phase 1 alternative in 2025.

³ Alternatives A1, A2, and B service consist of Rail Transit + non-redundant BRT and TSM combined in 2025.

⁴ Capital and O&M costs shown are exclusive of debt service and are in 2001 constant dollars. O&M costs for A1, A2, B are based on full implementation of all Phase 3 rail transit routes and includes operation of non-redundant TSM and BRT routes. Capital cost is rail only. O&M costs for the TSM alternative are for buses only.



MBTA CONTRACT NO. X2PS92 FILE L:\...URBAN\TAM\REPORT\STUDY\AREA.DWG



Urban Ring Corridor

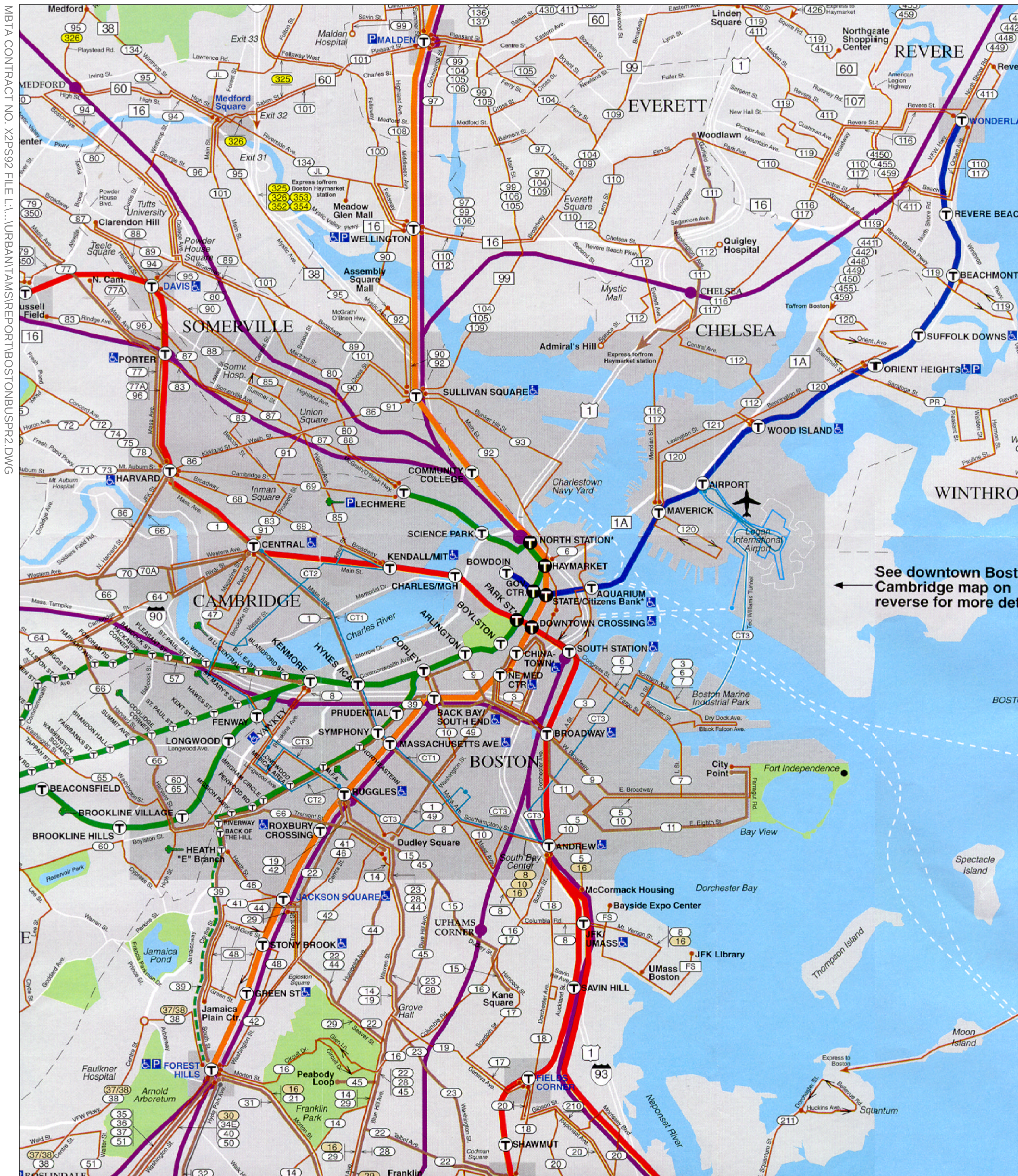
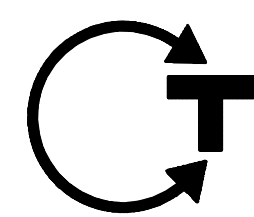
Study Area

Figure S-1

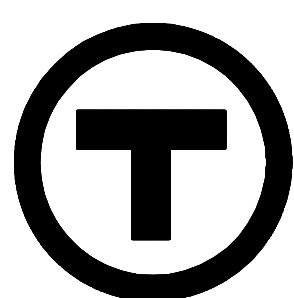
JULY 2001



URBAN RING MAJOR INVESTMENT STUDY



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Existing Public Transportation Network

Bus Routes and Radial Transit

MAY 2001

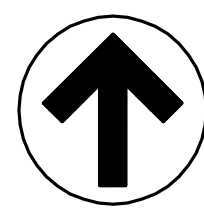
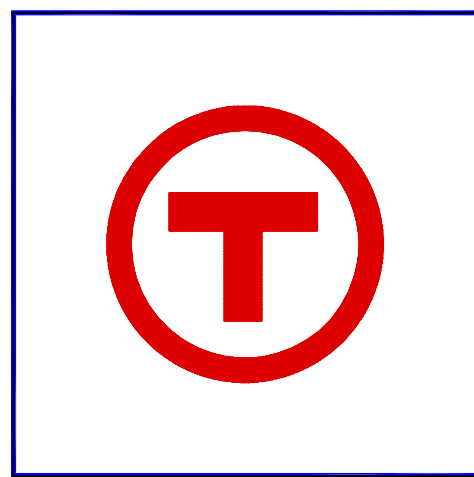
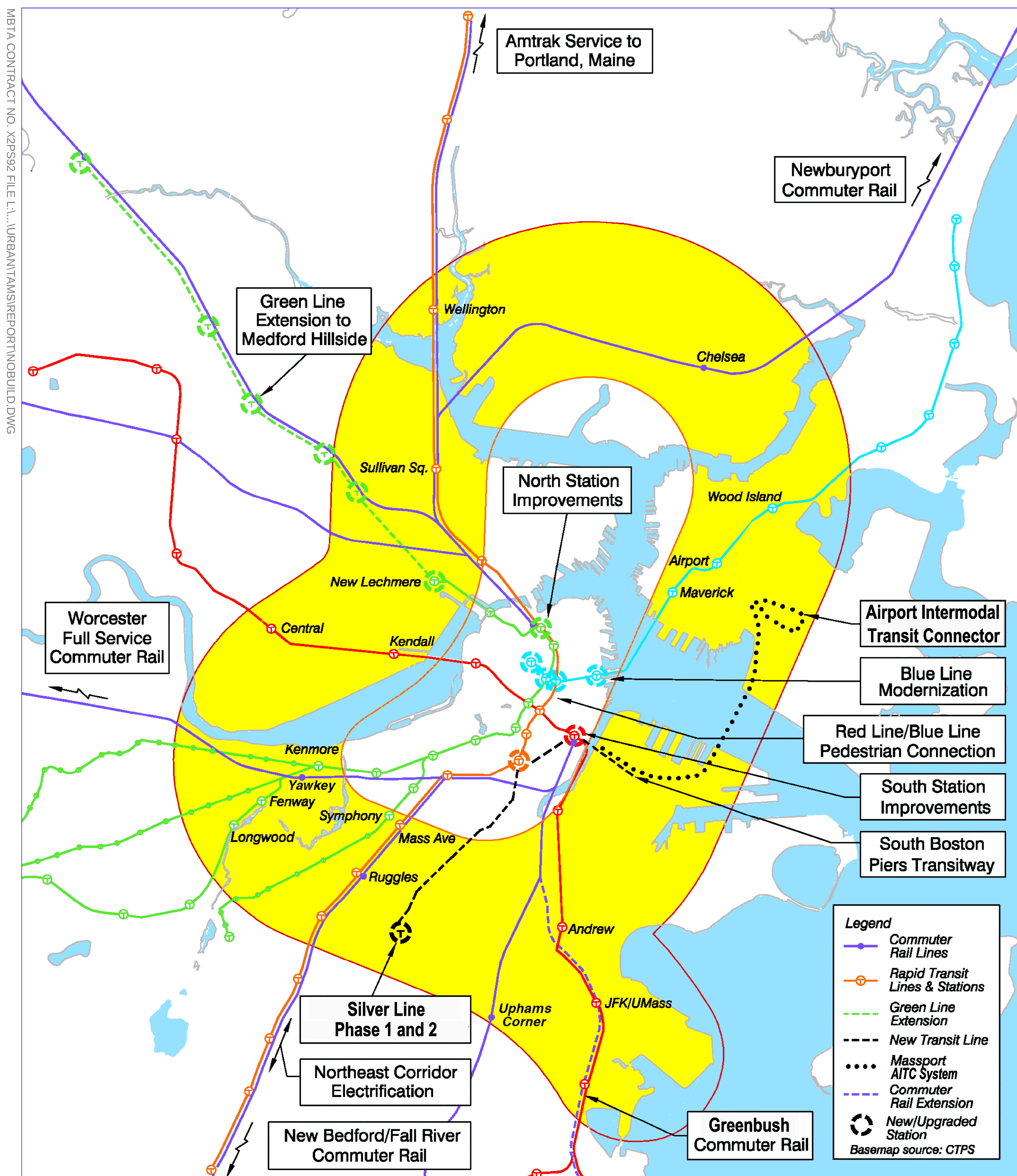


Figure 2-3

Not to Scale

URBAN RING MAJOR INVESTMENT STUDY



Public Transportation Network
2025 "No Build"

JULY 2001

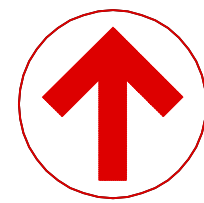
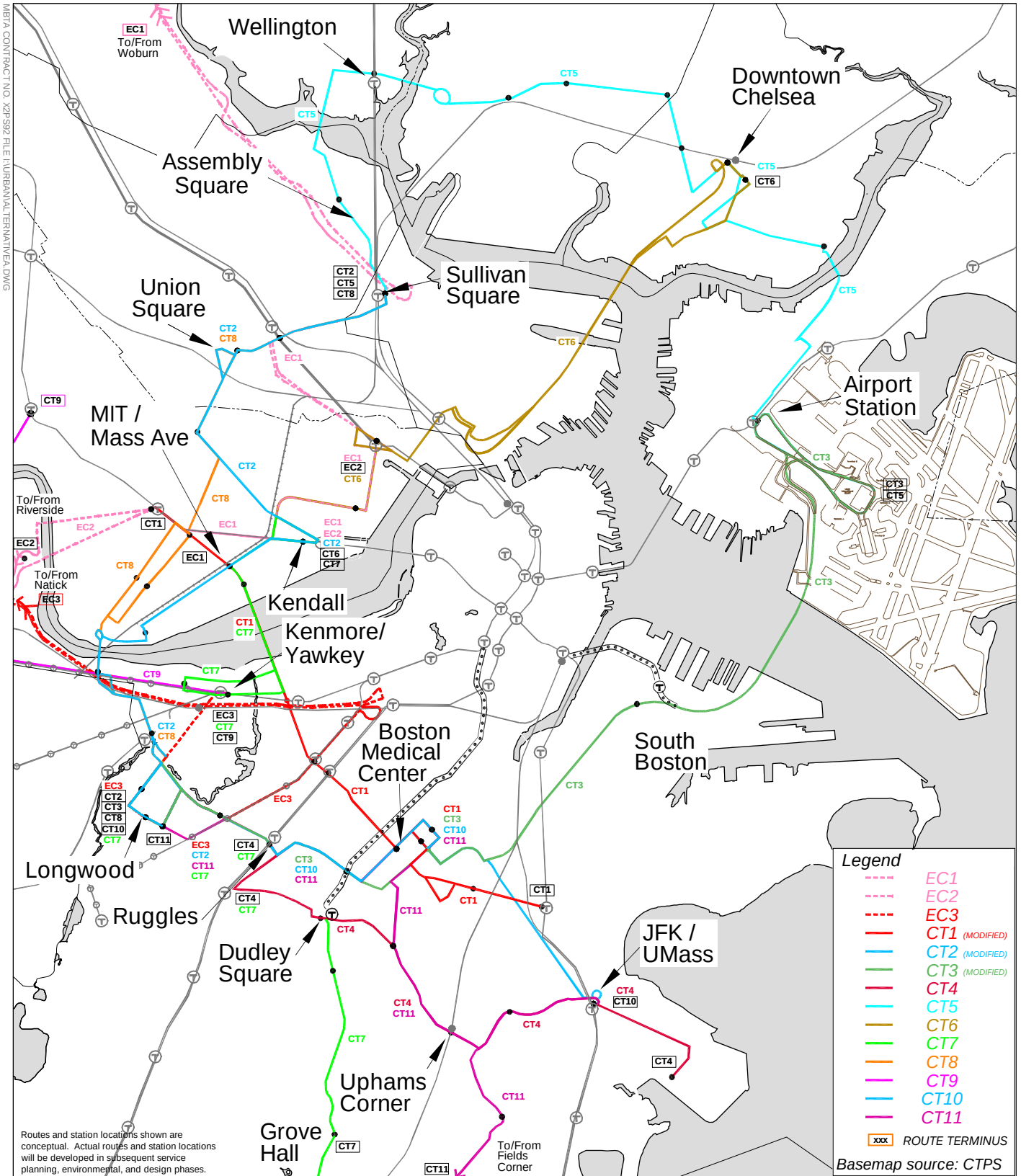


Figure S-3

Not to Scale



Urban Ring Corridor

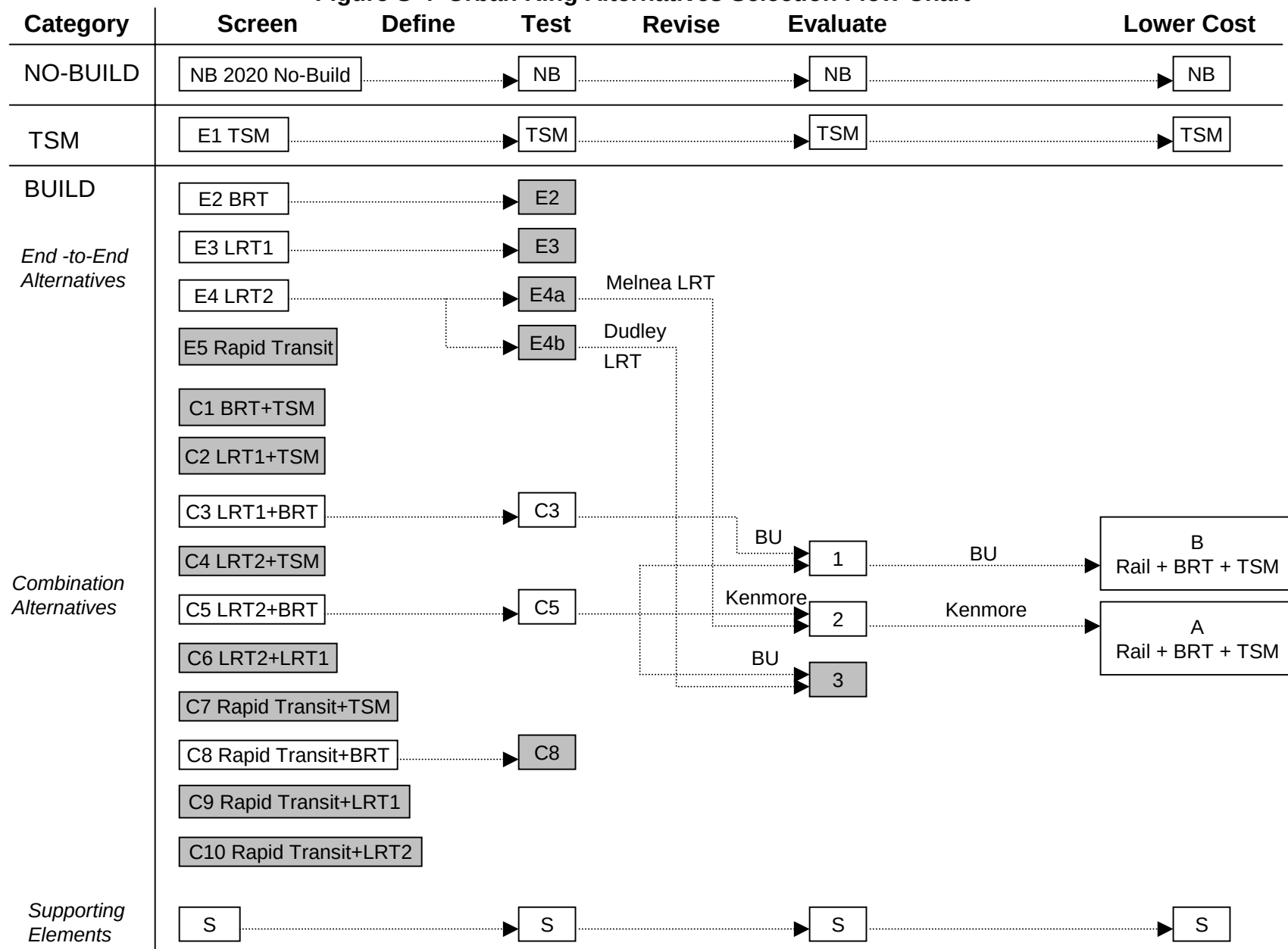
Phase 1 - Improved Bus Service

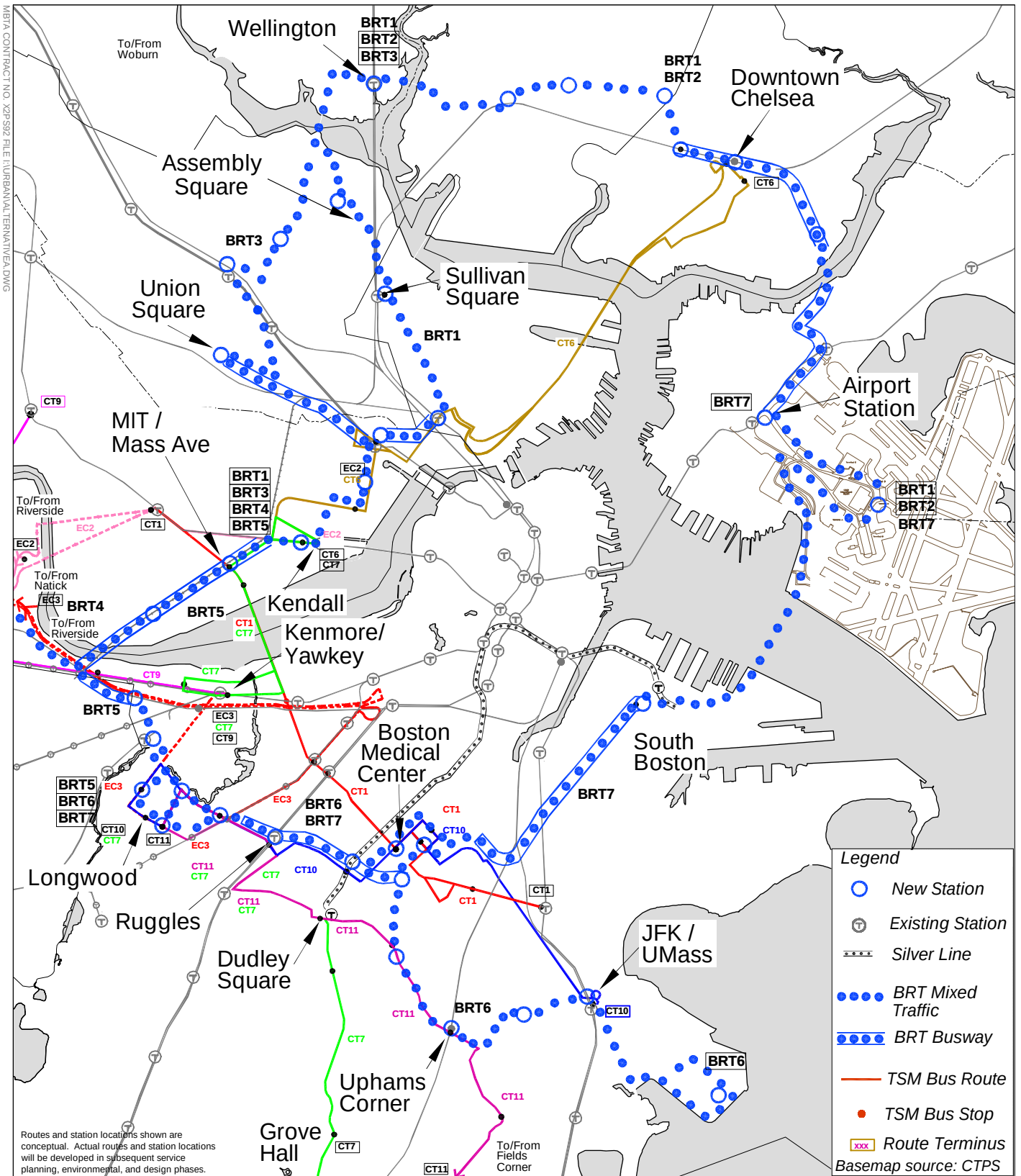
JULY 2001



Figure S-5

Figure S-4 Urban Ring Alternatives Selection Flow Chart





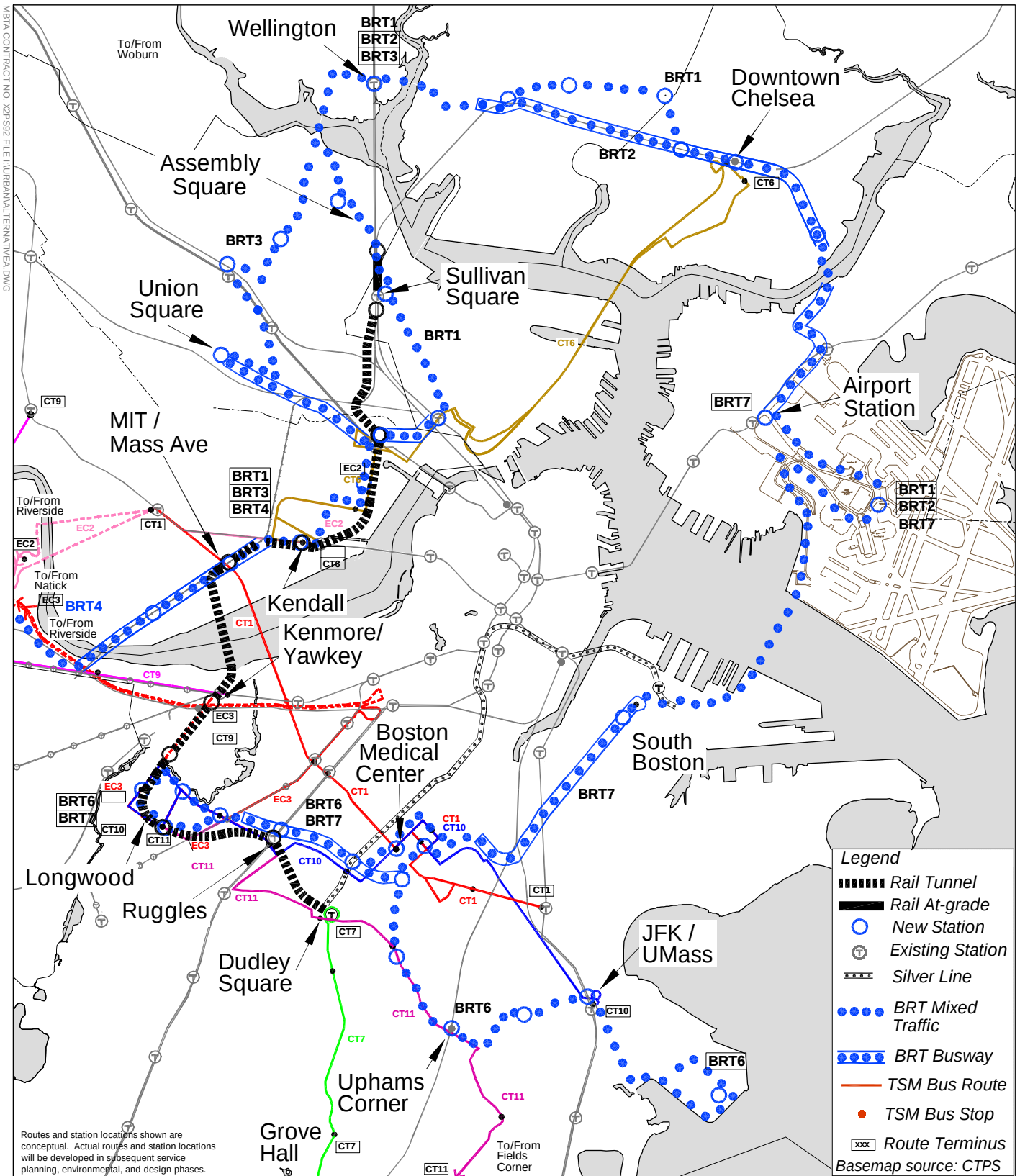
Urban Ring Corridor

Phase 2 - Bus Rapid Transit (BRT)

JULY 2001



Figure S-6



Urban Ring Corridor

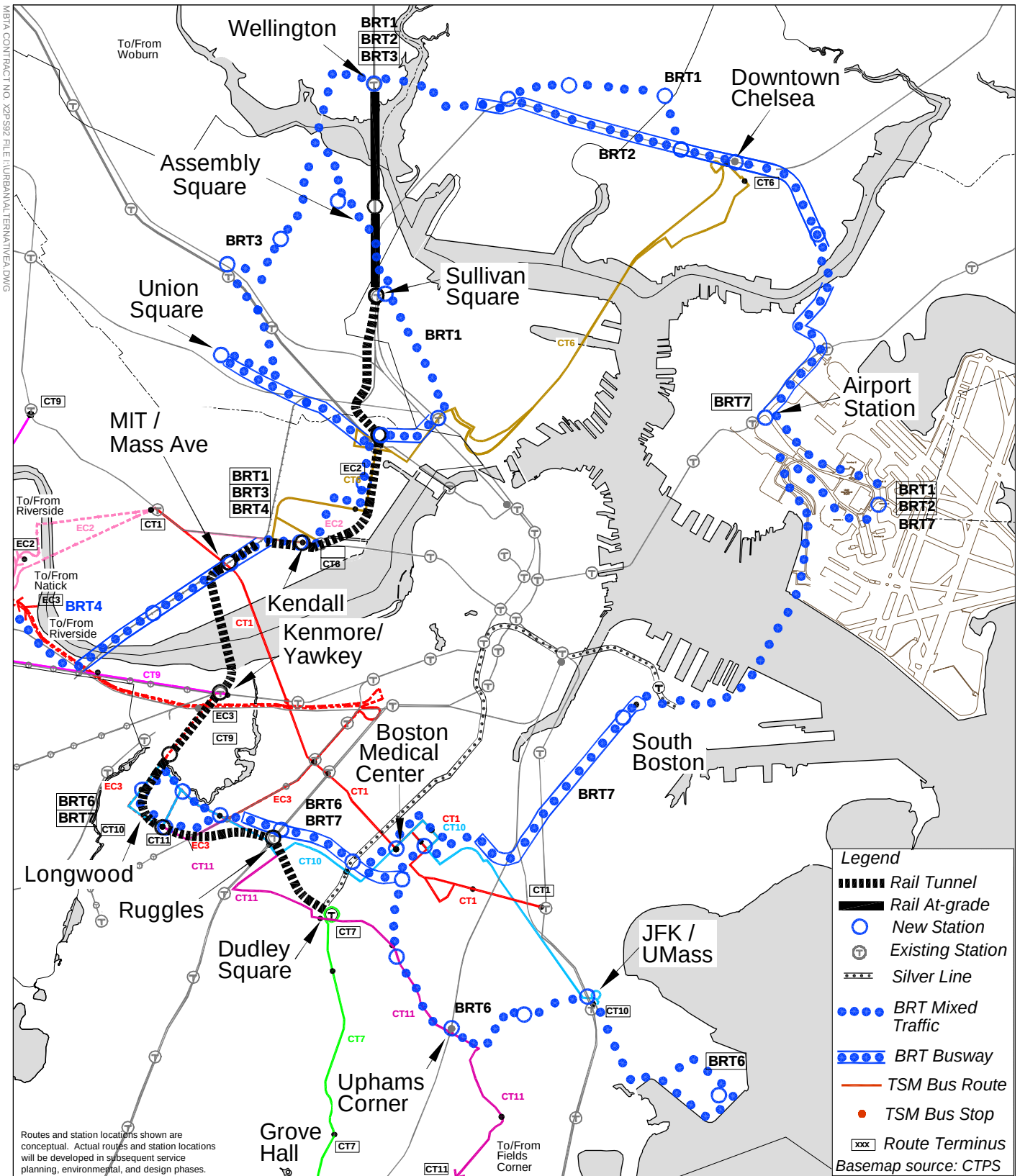
Phase 3 - Rail Alternative A1 - Kenmore

(LRT)

Figure S-7

JULY 2001





Urban Ring Corridor

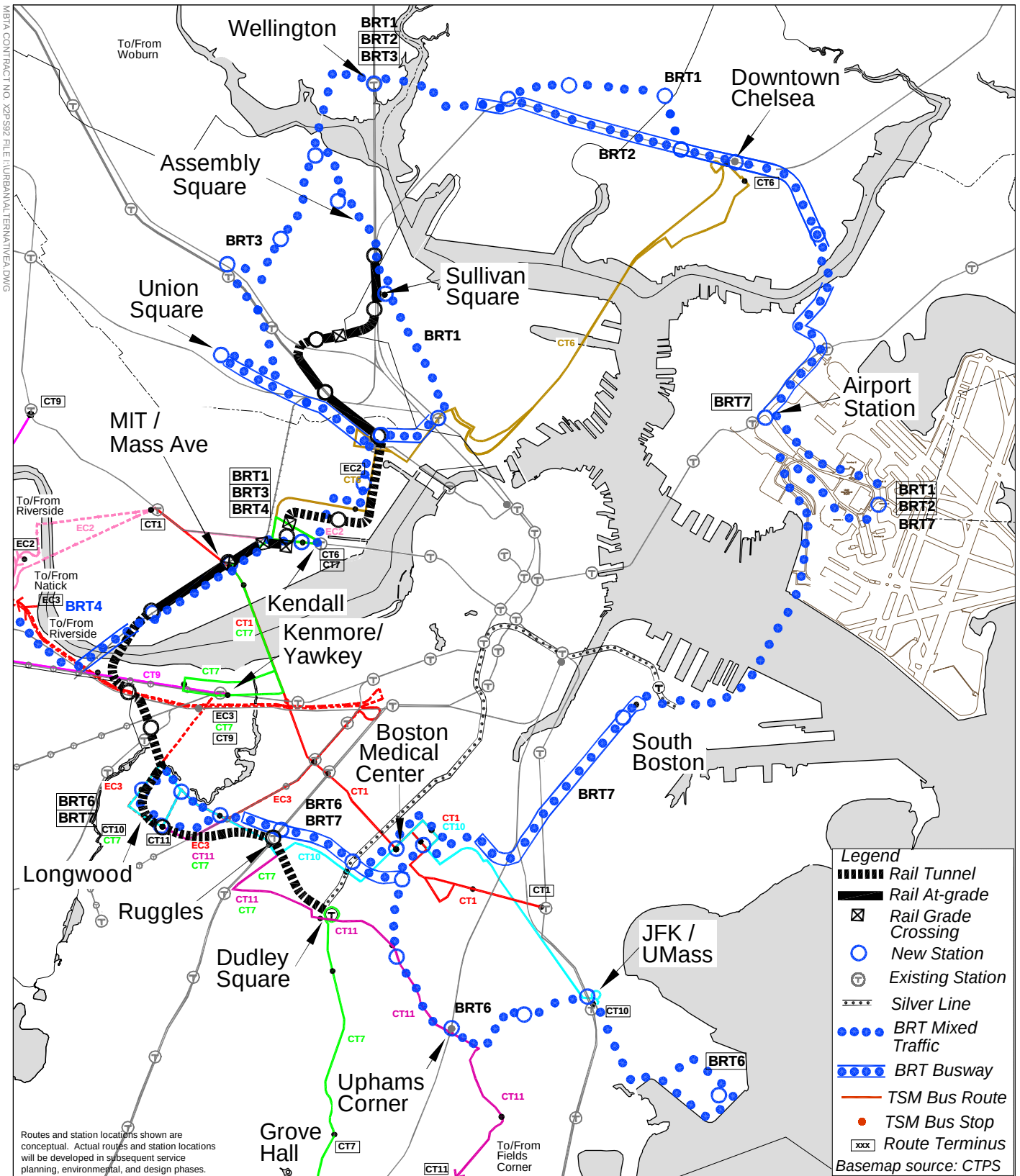
Phase 3 - Rail Alternative A2 - Kenmore

(Heavy Rail)

Figure S-8

JULY 2001





Urban Ring Corridor

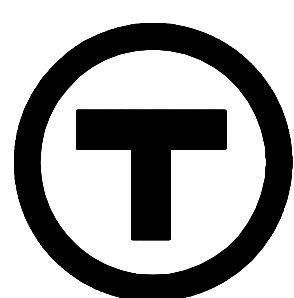
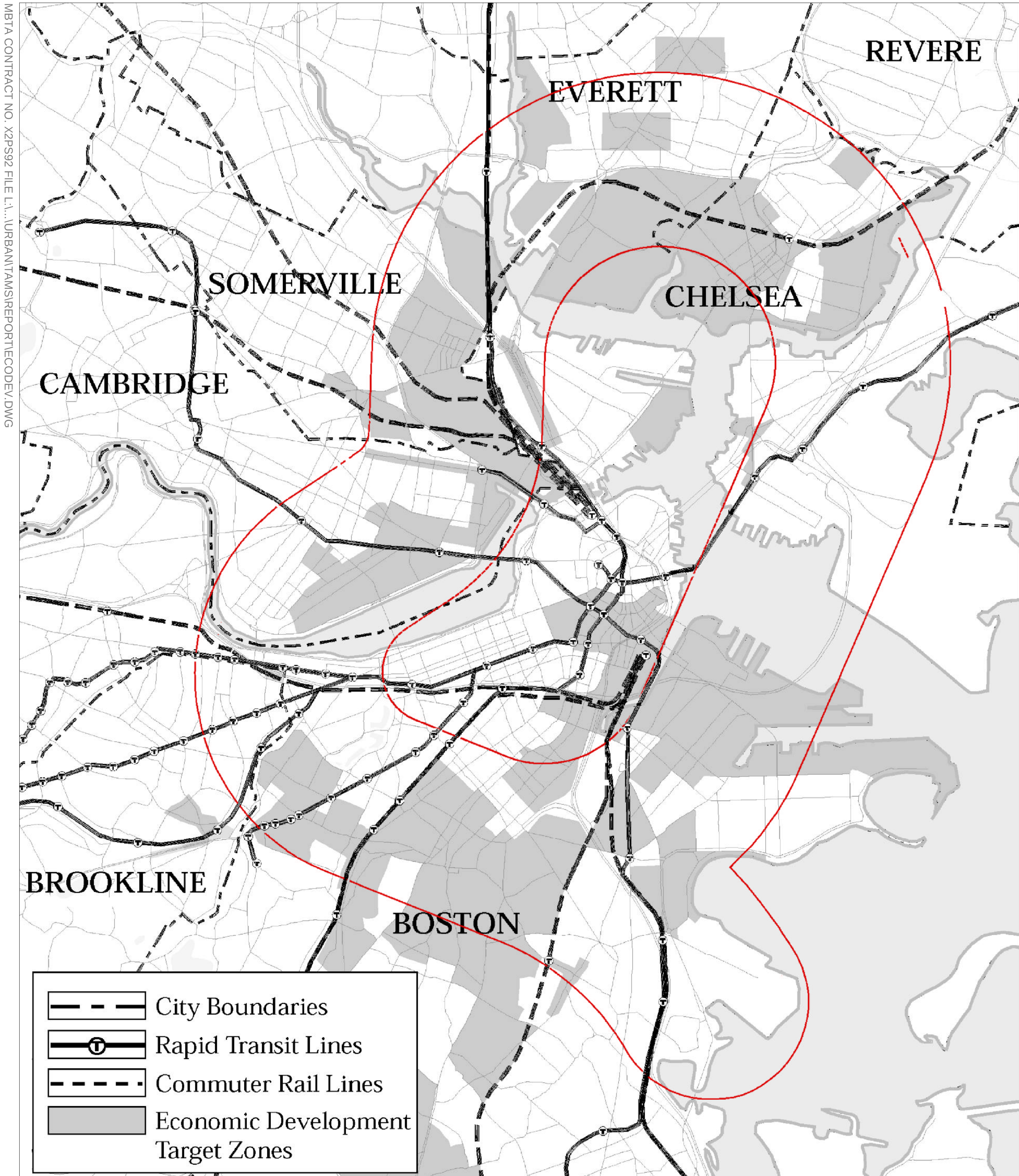
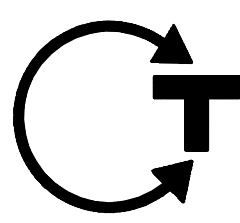
Phase 3 - Rail Alternative B - BU/Park Drive

(LRT)

Figure S-9

JULY 2001





Urban Ring Corridor

Economic Development Target Zones

MAY 2001

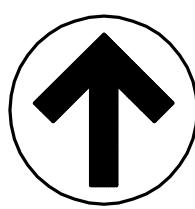


Figure S-10

Not to Scale

Figure S-11
Urban Ring Daily Ridership by Phase and Transit Mode

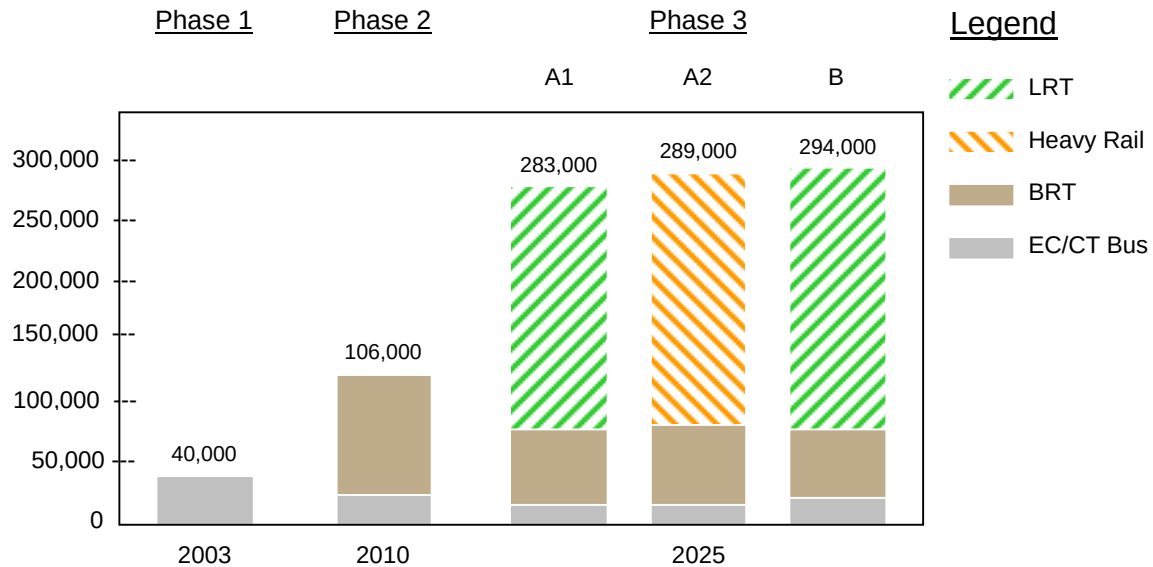


Figure S-12
Daily Boardings by Service in the MBTA System with and without the Urban Ring Year 2025

